ORIGINAL ARTICLE

Predictors of children´s successful defence against adult attacker

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A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: The paper is based on the presumption that the probability of successful defence of a child against an adult attacker is influenced by diversity of variables with different predictive values. The aim of the study are the best predictors and their presumably impact on children's chance to defend themselves.

Material & Methods: The research sample consisted of 48 students (40 female, 8 male) from three secondary schools. The average age was 16.6 years. Six self-defence experts performed ex-post evaluation of each video recorded scenario. Spearman's rank correlation coefficient, classification trees C&RT and logistic regression were used for analysis.

Results: Correlation between increasing personal score obtained by evaluation of selected criteria and the probability of a successful defence was confirmed by the high correlation $r_s = 0.735$ significance level of $p<0.05$. *Active defence, escape* and *technical* means respectively, were found the best predictors out of the total number of six evaluation criteria. *Communication* and *safe distance keeping* varied in the fifth position depending on the selected statistical method. *Guard position* was found the weakest predictor.

Conclusions: There are 13.88 times higher odds of successful defence when children are dealing with an adult attacker actively. The activity should be aimed at looking for an *escape* route as there are 7.69 times higher odds of successful defence when the child is trying to escape. Finally, there are 3.75 times higher odds of successful defence when the child uses appropriate *technical means* to distract attacker's attention.

Key words: combatives • defensive action • fighting skills • physical education • self-defence • self-protection • protective strategy • victimology

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Combatives - combatives are physical exercises aimed at physical defeat of a partner. Combatives comprise specific exercises which prepare a participant to overcome a partner by physical contact.

Defend actions – the act of defending yourself or someone or something from attack [45].

Defensive action – is the appropriate movement of the armed arm with weapon with intent to prevent the attack of opponent [45].

Particularly vulnerable victim - persons who are particularly vulnerable or who find themselves in situations that expose them to a particularly high risk of harm, e.g. persons subjected to repeat violence in close relationships, victims of gender-based violence, children, disabled people etc.

Self-defence - open system of any precautions and actions preventing victimization, deflecting acute threat using tactical, psychological, verbal or physical tools including use of reasonable force in accordance with the law in the defence of necessity and mitigation of the negative effects of assault.

Scenario training - the method used in the self-defence teaching both for training and evaluation purposes consisted in the pre-prepared course of a situation similar to a theatre script with fixed roles and activity of the actors where the roles of the actors (assailants) and the defender (a tested person) are already given.

Victim - a person who is actually and directly affected by an act or omission that is incompatible with the European Convention on Human Rights, or a person who is at risk of being directly affected [46].

Victimology - an area of criminology which studies the victim of crime and their relationship with offenders [46].

Victimization - the process in which one becomes a victim of crime.

Introduction

Children's self-defence is widely discussed concern [1-9] as children are by nature more vulnerable than adult people [10]. According to the legislation of European Union and Czech Republic, children are considered particularly vulnerable victims [11, 12] and in case of victimization they should be provided with specialist support and legal protection (e.g. interrogation in a special room by a person specifically trained, preventing re-encounter with the offender etc.). Parents are primarily responsible for their children but they cannot accompany them all day. Thus children must be responsible for their well-being and in case of risk situation use their own resources to defend themselves [2, 5]. There is much jeopardy in the environment nowadays and it is naturally not possible that one person cope with that all at the same time.

The aim of children's self-defence is not to create an ultimate protective shield but to develop personal strategy for each child based on their individual conditions and build habits for safe behaviour without any fear. Achieving a sense of comfort, irreplaceable by other feelings, concurrently with optimal psycho-physical readiness are the ultimate objectives of self-defence training [13]. Teaching of combative games (fun forms of martial arts [14]), combat sports, martial arts and self-defence should be considered a tool for developing risk management among children [15]. Learning by doing principle is an optimal approach for children's self-defence classes allowing them to develop their innate capabilities for self-reliance and an appropriate response in dangerous situations [1]. Children can benefit from self-defence teaching by establishing awareness, increasing self-confidence and self-discipline, developing mental strategies, improving communication skills, physical skills, fitness and the ability to fight back if necessary [5].

Taxonomy of combatives consists of three levels; the first level contains preparatory combatives, the second one combative sports and the third one self-defence, which is recognised as an application level of combatives in the defence of necessity by law [16-18]. Theory and didactics of combatives as well as self-defence are largely described in the literature with regards to psychological, technical, psychomotor, tactical, social, and legal aspects [13, 19-30]. The main objective of self-defence training is to increase participant´s defensive skills [31]. Of course, the motor competence is noticeably emphasized during the training process [23, 31], although from the praxeology point of view both physical and intellectual factors are influential on effect of any action [32].

Considering conditions in self-defence situations, we have to take into account that the physical defence is the last resort of self-preservation as the probability to win the real confrontation is unreliable. This presumption is especially valid when the defender is weaker than the offender (common modus operandi). From the tactical point of view the didactics of children's self-defence have to be divided into three separate types of risk situations according to the physical superiority of the opponent: defence against peers (e.g. an opponent of the same age and probably around similar physical mass), defence against youngsters considerably older and stronger than the defender (e.g. child at the age of 8 against a 15 years old bully) and defence against an adult assailant (e.g. a kidnapper, a mugger, or a rapist etc.). These levels are certainly simplified since big differences in the struggle between opponents can occur (e.g. an attacker of the same age but considerably more mature and stronger). On the other hand, previous research showed that physical fitness and body mass are not condition for the results of a hand-to-hand struggle; at least in children of the same age and adequate psychomotor competence they appear to be the prerequisite for winning a hand-to-hand struggle and self-defence [21].

There are many private companies offering self-defence courses for children where development of practical skills is expected and required [6-9]. Inclusion of combatives and self-defence in physical education has also been a topic for scholars [5, 19, 22, 24, 33-38] since many years. Our study following from the current situation in the Czech Republic presents self-defence not just as a commercial and a theoretical topic but as a regular part of physical education curricula of elementary and secondary schools [3, 4, 24, 38]. Although current curricula have been in force since 2007, proper academic research into evaluation of learning outcomes from self-defence classes is missing. The present study is a follow up to our previous publications [39-42] where conceptualization of children self-defence in PE classes and use of scenario training were given. Coming out from the results of scenario training in our High

School Self-defence Project (HSSP), we focused on the importance of all evaluation criteria and their predictive value for youngsters' successful defence against an adult assailant.

The aim of the study are the best predictors and their presumably impact on children's chance to defend themselves.

Material and methods

The study includes data collected during scenario training evaluation which was carried out as a final test of HSSP in 2011. Three secondary schools from Czech Republic were included in the project, where three PE teachers (2 female, 1 male) provided students with 12 self-defence classes according to HSSP methodology. Thereafter, scenario training (a simulation attack by an adult assailant) and evaluation of students' reactions were provided.

Participants

Students from three secondary schools (A, B, C) participated in the research. There were 19 female A school (Business Academy and Nursing School) participants,12 female and 8 male students B school (Nursing School) participants and 8 female C school (Sport High School) participants. Since out of the whole sample just 8 persons were male, we did not search for differences between tested persons by sex during the analysis. The total sample of tested persons was 48 (40 female, 8 male) at the average age of 16.6 years.

Methods

Scenario training

Scenario training is a frequently used method in the self-defence teaching both for training and evaluation purposes. The scenario is understood as a pre-prepared course of situation in which the roles of the actors are already given. To a certain extent, scenario training resembles a theatre script with fixed roles and activity of actors [43, 44]. In our research the scenario training was used for assault simulation by an adult person on teenagers. Each situation took place in a well-lit room which contained various objects (obstacles) [42].

Figurant´s role

The attacker´s task was to attack the tested person always first verbally and then physically. The attack was aimed with proportional intensity catch the tested person unawares and stress them, to make physical and psychical stress leading to the victory represented by knocking down and final defeat [42].

Tested person´s role

The task of the tested person was to enter the room and defend themselves against a possible attack of the figurant and escape. The tested person knew the room in advance but did not know the obstacles. The tested person knew in advance that they would become part of scenario training during which they would (probably) be verbally and physically attacked. The tested person also knew in advance that there would be a trainer and a researcher (both already known) and a third unknown person (figurant) with a mask covering the face.

Evaluation criteria

During the 12 self-defence classes of HSSP project students were taught to defend themselves both verbally and physically against a dangerous person by following the tactical plan: to occupy an appropriate position and posture for the defence, keep the safe distance from the dangerous person, answer verbally to attacker´s offensive activity, observe environment and look for escape route, repulse possible acute physical attack by appropriate technical means (e.g. push away, strike, kick etc.), and escape to safe distance or place. Mnemotechnical clue of traffic light was used for youngsters, where red light stood for first visual or verbal contact with the dangerous person enhancing the awareness, yellow light stood for verbal or physical defence and preparation of escape route and finally, green light stood for start and running away. Based on the above strategy, the elements listed in the Table 1 were selected as evaluation criteria of children´s correct behaviour in the self-defence situation [42].

These criteria were considered representative attributes of appropriate behaviour in youngsters´ self-defence which may enhance the defenders´ odds of successful defence. These evaluation criteria give evidence of the quality of defensive action of a tested person. The last and definitive evaluation criterion (C7) was the result assessment of scenario training. Tested persons´ behaviour was evaluated pursuant to successful or not successful defence of the tested person at the end of scenario. This evaluation criterion gives evidence of the result of defensive action of the tested person.

Table 1. Evaluation criteria and their description.

Code	Evaluation criteria	Description
C1	Guard position	Occupies an appropriate position and posture for the defence (hidden guard, defensive guard, offensive guard etc.).
C2	Communication with the attacker	Communicates with the attacker and the environment (uses a call, trap, calls for help etc.).
C3	Safe distance keeping	Works correctly with the distance (elongation, shortening, maintenance).
C4	Active defence against attack	Actively defends him/herself against the attack.
C5	Technical means for distracting from the attacker	Uses appropriate technical means to defend him/herself.
C6	Escape to a safe place	Course of defence heads towards breaking away from the attacker and escaping to the safety.

Experts' assessment

Six self-defence experts evaluated each video recorded scenario situation ex-post. Behaviour of each tested person was evaluated dichotomically (0 or 1) in the excel file using selected C1-C7 criteria mentioned above.

Statistical analysis

After provided experts' assessment we proceeded to analyse the data which consisted of dichotomical evaluation of all criteria. Three statistical methods were involved to analyse the data and verify the results. Each tested person obtained 0 or 1 evaluation for each C1-C7 criterion. The sum of evaluation of six C1-C6 criteria created a personal score given by each of six experts. Arithmetic mean of six personal score was set up as a definitive value of personal score which was used for further analysis. By evaluation of C7 criterion the ratio of experts unity was created, defined as "defended: not defended". This ratio was transformed into numerical value according to conversion table (Table 2).

Table 2. Conversion table of expert assessment of numeric value.

Ratio of experts unity	Numeric value
00:05	0
01:04	0.25
02:03	0.5
03:02	0.5
04:01	0.75
05:00	1

For determination of dependence between definitive personal score and ratio of experts unity on scenario result Spearman's rank correlation coefficient was used. Two statistical methods were involved for the analysis of predictors of successful defence: C&RT classification trees and logistic regression.

C&RT classification trees

In a standard classification tree the idea is to split the dataset according to homogeneity of data. The main idea of tree methods is to divide recursively the data into smaller and smaller strata in order to improve the fit as best as possible. The sample space is originally split into two regions. For each of the two created regions this process is repeated again. The major components of the C&RT methodology are selection and stopping rules. The selection rule determines which stratification to perform at each stage and the stopping rule determines the final strata that are formed. Once the strata have been created, the impurity of each stratum is measured. The heterogeneity of the outcome categories within a stratum is referred to as "node impurity". In each node the variable by which we divide the data file and borders is determined, showing where the division was done. The method enables to arrange the variables according to their classification importance.

Logistic regression

Logistic regression measures the relationship between the categorical dependent variable and one or more independent variables by estimating probabilities using a logistic function. Like other forms of regression analysis, logistic regression makes use of one or more predictor variables that may be either continuous or categorical. The logit of success is then fitted to the predictors using

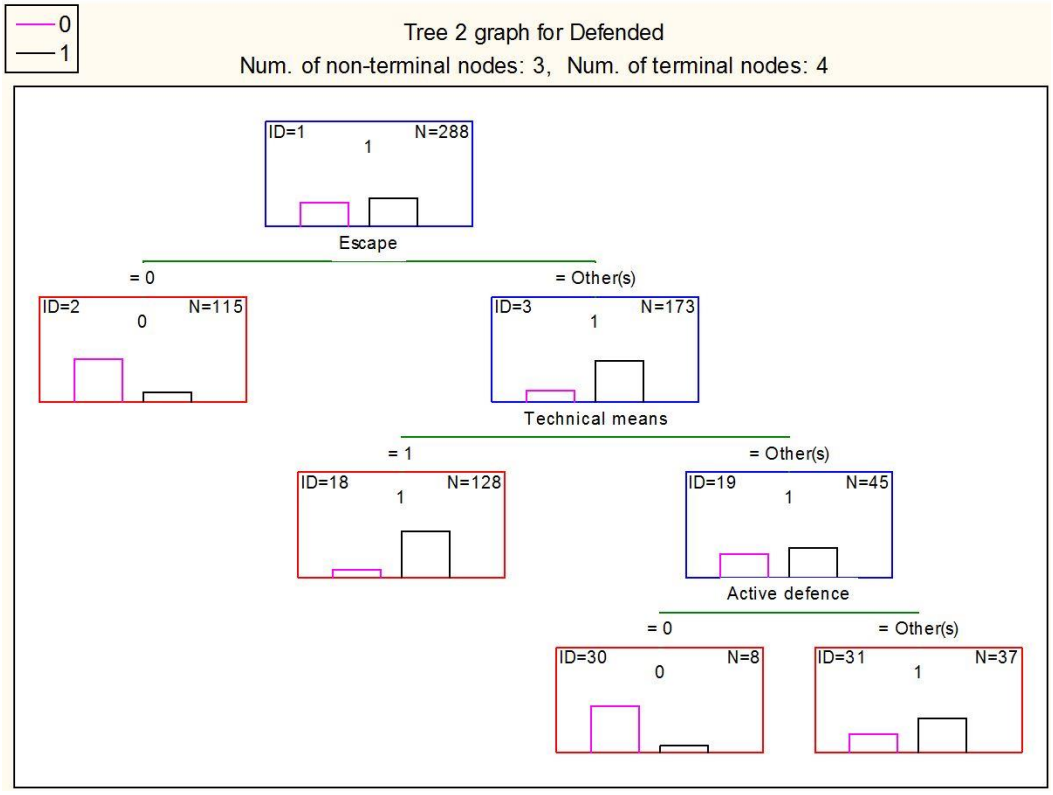

Figure 1. Binary tree with classification schema.

linear regression analysis. The predicted value of the logit is converted back into predicted odds via the inverse of the natural logarithm, namely the exponential function. Thus, although the observed dependent variable in logistic regression is a zero-or-one variable, the logistic regression estimates the odds as a continuous variable whose dependent variable is a success (a case). This categorical prediction can be based on the computed odds of a success, with predicted odds above individual selected cut-off value translated into a prediction of a success.

Results

Spearman's rank correlation coefficient between the tested persons´ personal score and the ratio of experts unity on scenario result reaches the value $r_s = 0.735$. This is high correlation at a significance level of $p<0.05$. The calculation shows a correlation between the increasing personal score and the probability of a successful defence. We interpret the result as follows: C7 evaluation criterion (result of scenario training) is dependent on the quality of defence expressed by C1- C6 evaluation criteria.

In the following analysis, we concentrated on finding out which of the C1-C6 evaluation criteria are the best predictors for successful defence. C&RT classification trees show the best model of predictors (Figure 1, Table 3).

Figure 1 and Table 3 display the tree with schema of variables classification. Each node is designated by its ID and includes the number of cases and frequency rate of a dependant variable. There is a branch with information about rule from each node which divides the node into 2 subnodes (binary tree). Out of total number of n = 288 measurements in the ID = 1 node the number of n = 131 cases were not successful in defence and n = 157 cases were successful. This group is best divided by *escape* variable into two subnodes: ID = 2 and ID = 3. The ID = 2 node incorporates the sum of 115 cases which did not meet the *escape* criterion. Out of this node n = 94 cases were not successful in defence and n = 21 cases succeeded. There is a total number of n = 173 cases in the ID = 3 node which met the *escape* criterion. Out of this node n = 37 cases did not succeed in defence and n = 136 cases were

Table 3. Structure of binary tree.

Node #	Tree structure 2 Dependent variable: Defended Options: Categorical response, Tree number 2								
	Left branch	Right branch	Size of Node	N in class 0	N in class 1	Selected category	Split variable	Split constant	Split category
1	2	3	288	131	157	1	Escape		0
2			115	94	21	0			
3	18	19	173	37	136	1	Technical means		1
18			128	17	111	1			
19	30	31	45	20	25	1	Active defence		0
30			8	7	1	0			
31			37	13	24	1			

successful. This node is further best divided by *technical means* variable into 2 subnodes: ID = 18 and ID = 19. Out of the total number of n = 128 cases in the node ID = 18, which used technical means, n = 17 were not successful and n = 111 were successful. The node ID = 19 consists of n = 45 cases which met *technical means* criterion. In that node there was almost a balanced number of cases connected with unsuccessful defence (n = 20) and cases with successful defence (n = 25). This node is further best divided by *active defence* criterion into 2 subnodes: ID = 30 and ID = 31. In the ID = 30 node cases which did not meet *active defence* criterion appeared (n = 8). Out of this node n = 7 cases were not successful in the defence and just n = 1 was successful. On the other hand, cases fulfilling the *active defence* criterion were included in the node ID = 31. Out of the total number of n = 37 in that node, n = 13 cases were connected with unsuccessful and n = 24 with successful defence.

Based on the results of C&RT analysis displayed in the Figure 1 and Table 3, we can conclude that the best predictors for successful defence are *escape*, *technical means* and *active defence* respectively. In other words, the greatest chance of successful defence had those tested persons who were trying to escape (criterion *escape* = 1), while the best predictor for failure was criterion of *escape* = 0. The probability of success in defence increased with meeting criterion of *technical means* = 1. Moreover, the chances of success increased in tested persons who were vigorous in the defence and met the criterion of *active defence* = 1. Another point of view of predictors is offered by the allocation of independent variables (C1-C6 criteria) according to their importance of successful defence (C7 criterion). The Importance plot (Figure 2) shows the best predictors which mostly affect the dependent variable of Defended.

Based on the data in Figure 2 we conclude that the best predictors for successful defence are evaluation *active defence* (C4), *escape* (C6), *technical means* (C5), *safe distance keeping* (C3), *communication* (C2) and *guard position* (C1) criteria respectively.

To verify the model quality, we provided the analysis of good and bad included cases. Since there are correct classifications (Table 4), we consider the model successful.

Table 4. Rate of classification success in C&RT

#	Frequency table for predicted variable Predicted Observed variable: Observed		
	OBSERVED	PREDICTED	COUNT
	Observed	Predicted	
1	0	0	101
2	0	1	30
3	1	0	22
4	1	1	135

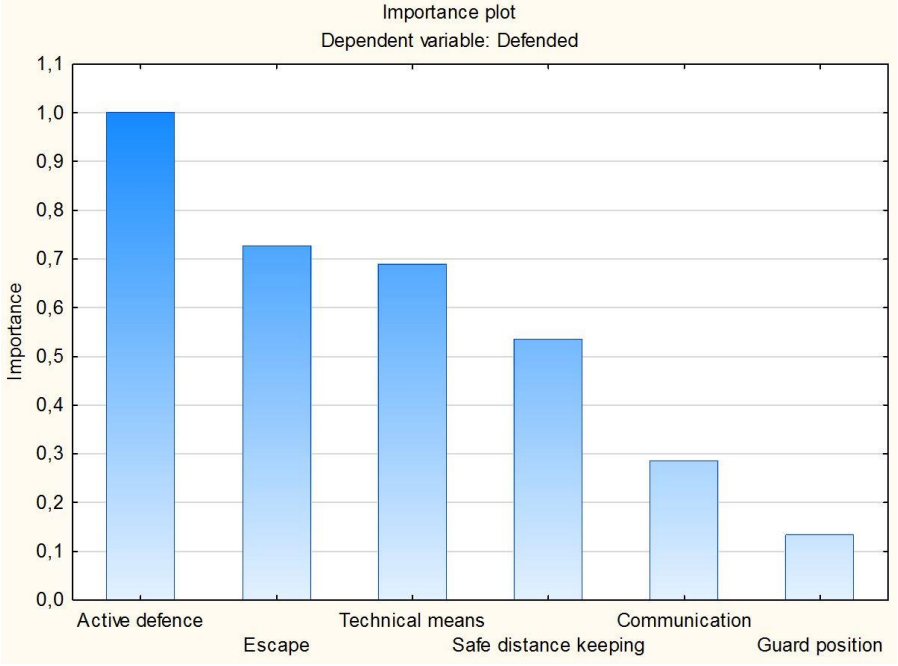

Figure 2. Importance plot of evaluation criteria

Table 5. Odds Ratios for successful defence

Effect	Defended - Odds Ratios Distribution : BINOMIAL, Link function: LOGIT Modelled probability that Defended = 0					
	Level of effect	Column	Odds Ratio	Lower CL 95.0%	Upper CL 95.0%	p
Intercept		1				
Guard position	0	2	0.596	0.277	1.283	0.186
Communication	0	3	3.033	1.376	6.687	0.006
Safe distance keeping	0	4	2.069	0.947	4.521	0.068
Active defence	0	5	13.882	2.683	71.833	0.002
Technical means	0	6	3.746	1.837	7.640	0.000
Escape	0	7	7.691	3.786	15.626	0.000

Logistic regression was performed by the following procedure. Variable of Defended (C7) was determined as a dependent variable and C1-C6 evaluation criteria of *guard position*, *communication*, *safe distance keeping, active defence, technical means* and *escape* as independent variables. Most relevant results of logistic regression are displayed in the Table 5.

Based on the data presented in the Table 5, we determined the best predictors for successful defence in the following order: 1) *active defence*, 2) *escape*, 3) *technical means*, 4) *communication*. Explicitly, the tested person with *active defence* = 0 evaluation has 13.88 times higher odds of unsuccessful defence (Defended = 0) than the tested person with *active defence* = 1 evaluation. The tested person with *escape* = 0 evaluation has 7.69 times higher odds of unsuccessful defence (Defended = 0) than the tested person with *escape* = 1evaluation. Tested person with *technical means* = 0 evaluation has 3.75 times higher odds of unsuccessful defence (Defended = 0) than the tested person with *technical means* = 1evaluation. Tested person with *communication* = 0 evaluation has 3.03 times higher odds of unsuccessful defence (Defended = 0) than the tested person with *communication* = 1 evaluation. For verification of our

Table 6. Model quality

Indicator	Defended - Statistics of goodness of fit Distribution: BINOMIAL, Link function: LOGIT Modelled probability that Defended = 0 (Analysis sample)		
	Df	Stat.	Stat/Df
Deviance	281	224.505	0.799
Pearson Chi2	281	227.103	0.808
AIC		238.505	
AICC		238.905	
BIC		264.146	
Cox-Snell R2		0.450	
Nagelkerke R2		0.602	

Table 7. Rate of classification success in logistic regression

	Classification of cases Odds ratio: 25.965714 Log odds ratio: 3.256777		
	Predicted:0	Predicted:1	Percent correct
Observed: 0	96	35	73.282
Observed: 1	15	142	90.446

results we tested the model quality (Table 6).

Since the p-value = 0.798951 for deviance goodness of fit test and p-value = 0.808195 for Pearson chi-square goodness of fit test, we conclude hypothesis that the logistic regression response function is appropriate. The R^2 measures of predictive power of 0.45 and 0.6 confirm the appropriateness of the model. The total success rate of classification (Table 7) in our model is .

The model quality was also confirmed by ROC curve (Receiver Operating Characteristic, Figure 3). It is a tool for assessing and optimizing the binary classification system (test) that shows the relationship between the specificity and sensitivity of the test or the detector for all permissible threshold value. The vertical axis of the ROC curve is the relative frequency of true positive cases i.e. the probability that as a correct one will be evaluated positive case. The horizontal axis is the relative frequency of false positive cases, i.e. the probability that as a correct one will be evaluated negative case. The best model is the one with the largest area under the curve which can theoretically reach the value of 1.00. In our analysis the value equals 0.8992.

Discussion

Although we found quite precisely the best predictors for successful defence of children against an adult attacker using different statistical methods and verifying quality of the models, we have to consider following limitations of our study.

Firstly, we did not analyse real self-defence cases but confrontation between an adult assailant and youngsters in a simulated scenario training. Thus our study is limited by all limitations typical of scenario training in general. These limitations include for instance knowing the tested persons, awareness of the fact that the attack is simulated and no real threat is present. Furthermore, it is the absence of other citizens who can witness the real situation in the public environment etc. In addition, all possible factors which could be present in the real eco-system (multiple attackers, use of weapons etc.), could play additional role in the real situation. Due to this the number of factors is limited by the design of scenario training which focuses on one tangible situation. On the other hand, the attack of one person in a confined space was realistic enough and children experienced it very emotionally. We consider the course of simulation well-structured and adequate for the research purposes.

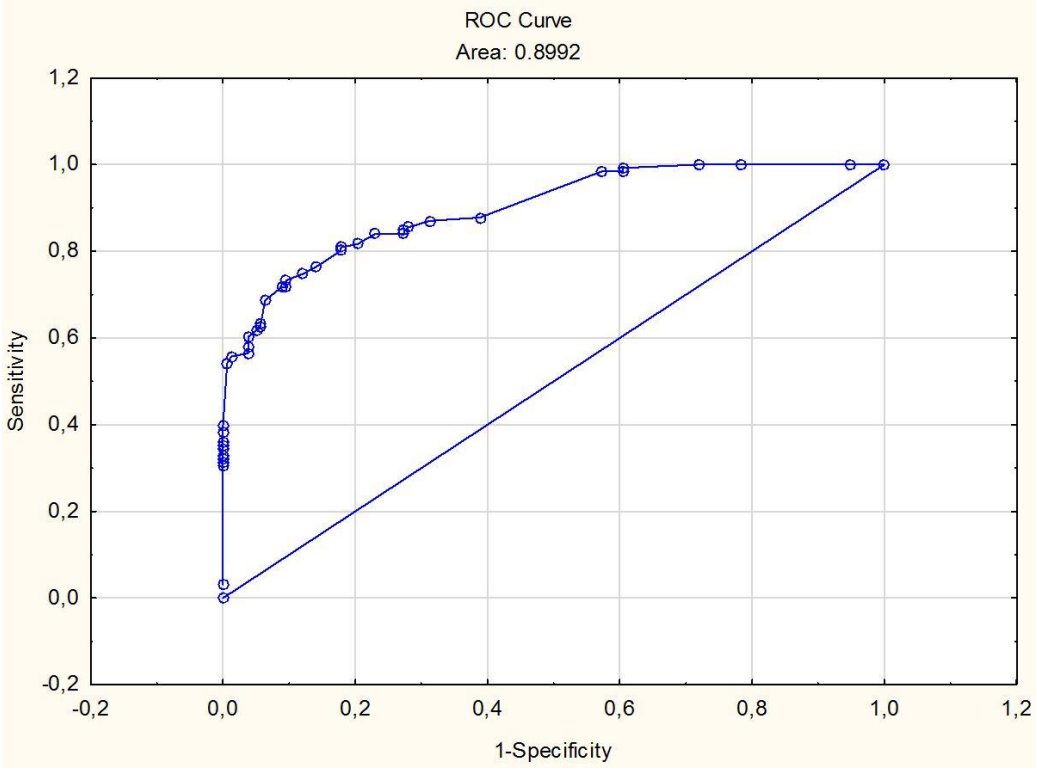

Figure 3. ROC curve

Finally, our study focuses on predictors which were previously considered influential in self-defence situations. Although we regard these six predictors as representative attributes of appropriate behaviour of children facing violence from an adult attacker, there could be other influencing factors which we did not include in the analysis. On the other hand, we consider the high correlation (r_s = 0.735, significance level of $p<0.05$) between personal score of tested person, which is created from selected evaluation criteria, and the result of scenario to be the evidence of valid selection of these criteria.

Conclusions

Predictors of children´s successful defence against an adult attacker were explored by two statistical methods. Both C&RT classification trees and logistic regression methods confirmed that from the total six evaluated criteria the best predictors are *active defence*, *escape* and *technical means* respectively. Additionally, *communication* and *safe distance keeping* varied in the fourth and fifth position dependently on the selected statistical method. *Guard position* emerged as the weakest predictor. Both for the didactics and evaluation of children´s self-defence training following practical implications are relevant. The activity itself is the most important predictor for self-defence situation solving.

According to the logistic regression there are 13.88 times higher odds of successful defence when the child behaves actively against an adult attacker. The activity should be aimed at looking for escape route as there are 7.69 times higher odds of successful defence when the child is trying to escape to the safe place. There are 3.75 times higher odds of successful defence when the child uses appropriate *technical means* to distract the attacker, which enables them to *escape*. Finally, when the child *communicates* with the attacker correctly, there are 3.03 times higher odds of success in the self-defence situation. Although *safe distance keeping* and *guard position* appeared the weakest predictors, we have to realize that these factors are significant tactical elements especially in the pre-conflict phase. Having regard to the foregoing limitations, further research with wider scope of predictors is recommended for more complex understanding of the matter.

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