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SPINSHOT THROW IN U18 JUNIOR BEACH HANDBALL: THE EFFECT OF GROUND FORCES

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Abstract: The game of beach handball is constantly expanding and its impact is increasing**.** The purpose of this study was to determine to what extent an intervention program can improve the value of ground forces in the spin shot goal throw. The study was composed of 13 sportswomen, aged between 16-18 years. The proposed intervention program took place over a period of 5 months (02.01.2020-06.01.2020) and was included in the annual training plan for female handball players. Throughout this period, the technical preparation of the throw at the goal from the pirouette (spin shot) was pursued through the use of a varied range of specific exercises. The AMTI NET force platform, model BP400600, was used to evaluate the forces generated on the ground, offering high accuracy. The platform offers both force analysis and algorithms to calculate variables such as: center of pressure, standard deviations, radial measurements, balance parameters. The results of this study showed us significant statistical differences for the parameters of performing the technical procedure without run up (HTS), FxImp ($p= 0.05$), Tq ($p= 0.01$), and as regards the performance of the complete technical procedure – with run up (JHT) we found statistically significant differences in the parameters TEx ($p= 0.01$), FzImp ($p= 0.03$), Tq ($p= 0.01$). Our study identified that the exercises used determined an increase in the values of the anterior-posterior impulse, the force torque, the execution time and the vertical impulse, the most important parameters for the achievement of the technical procedure of the throw to the goal from the spinshot in the beach handball game.
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Key words: ground forces, spinshot throw, beach handball, juniors

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INTRODUCTION

Studies of major beach handball competitions have highlated the need to improve the efficiency of 2 points-goal throws. Among the technical medthods of throwing at the goal, the most frequently used are spinshots throws (Gehrer & Posada, 2010; Gruic et al., 2011; Zapardiel, 2018; Saavedra et al., 2019).

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The tehnique of throwing the ball in the game of beach handball is very important in achieving succes, but it does not depend only on muscle strength, but also on aspects regarding the coordination of the body segments and the skills that the athlete has (Gorostiaga, 2006; Granados et al., 2007; Saeterbakken et al., 2010).

Throwing at the goal is a technical element that is learned from the initiation period. It is perfected and strengthened in the subsquent stages of preparation. The goal throwing procedure often used in the beach handball game is the spinshot goal throwing. It is performed by jumping, but it is more complex (a twist in the air is added). It requires attention to learning, so that the athlete learns the movement corectly (van den Tillar & Ettema, 2004; 2006; Wagner et al., 2010).

In beach handball, during the spinshot goal throw, the unstable surface imposes a different movement to achieve the rotation of the torso and allow the transfer of momentum to the throwing arm, thus forcing the coaches to develop the forces necessary to achieve this procedure by the athletes. An important role is also how the athlete manages to use the reaction force of the support surface in increasing the force and efficiency of the throw.

THE PURPOSE OF THE STUDY

The purpose of the study was to determin to what extent an intervention program can improve the value of ground forces in the spinshot goal throw.

MATERIALS AND METHODS

Subjects of the study

Thirteen sports school handball players, aged between 16-18 years participated in this study. The athletes gave their formal consent to participate in this study, wich was also signed by their parents or guardians. School consent was also obtained.

Program intervention of the study

The proposed intervention program took place in the gym, over a period of 5 months, with three training sessions per week (Monday – Wednesady – Friday), each session lasting 90 minutes, and the program was included in the annual traning plan for female handball players. Throughout this period, the technical preparation of the throw at the goal from spinshot was pursued through the use of a varied range of specific exercises.

Assistive objects such as gymnastics trampolines and mattresses were used in this training program. The gymnastics trrampoline helped the athletes to get off the ground and perform the jump as high as possible, in order to achieve a complete twist in the air at the time of the goal throw. Gymnastics mattresses were used to imitate the unstable surface of sand, so that the athletes could perform spinshot at the goal in an environment as close as possible to the game of beach handball.

The exercises used in this training period were varied. Shots at goal from 90-degree, 180-degree and full turns were performed both from the spot and from the distance (walking and running), but also from different positions in front of the goal (left side or right side). Drills in which the attacking players are in numerical superiority such as 2 vs 1, 3 vs 2, were carried out at a goal at the beginning, with the completion of attacks from the sides of the field, with passive, semi-active and active defenders. At the end of the training program, school games were performed with different themes in which the athletes completed any attack with a throw at the goal with a spinshot from the jump.

Measurments instruments used in this study

The AMTI NETforce platform, model BP400600, was used to evaluate the forces generated on the ground, offering high accuracy. It is made of aluminum with a weight of 31.82 kg and dimensions of 400x600x82.55 mm. The platform offers both force analysis and algorithms to calculate variables such as: center of pressure, standard deviations, radial measurements, balance parameters, etc.

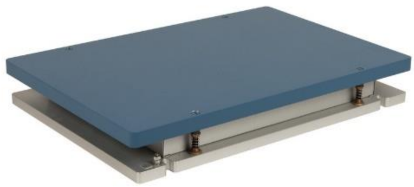

Fig. 3 AMTI Netforce Platform (amti.biz, 2020)

Out of all the variables that the analysis program offers, we tracked the following: Vertical Impulse (FzImp), Anterior-Posterior Impulse (FxImp), Damping Force (F_{amr}), Pushing Power (P_{imp}), damping (P_{amr}), execution time (TEx), force torque (Tq), mechanical work when pushing (L_{imp}), mechanical work when damping (L_{amr}), these parameters being the most important factors in performing the technical procedure of throwing at the goal from spinshot. They refer to the following:

- The vertical impulse (FzImp) indicates the subjects' ability to change their state of motion during the procedure. This parameter highlights the moment between damping and thrust.
- The anterior-posterior impulse (FxImp) quantifies the change in the state of motion of the subjects towards the goal.
- The damping force (F_{amr}) has an indirect relation with the muscle force, since the push into the platform is carried out by the locomotor system
- Pushing power (P_{imp}), we find it at the moment of pushing within the technical procedure of throwing at the goal from spinshot, indicating the consumption of energy resources during execution.
- The damping power (P_{amr}) can differentiate the damping during the execution of the technical procedure of throwing at the goal from spinshot, so that a short execution time indicates a high energy consumption leading to the optimal preparation of the other phases of the procedure.
- The execution time (TEx) shows us the unit of time required to perform the technical procedure of throwing at the goal from the spinshot.
- The torque (Tq) on damping indicates the stability of the subjects at the moment of landing before performing the throwing procedure.
- The mechanical work of pushing (L_{imp}) illustrates the energy consumption at the moment of pushing during the performance of the technical procedure of throwing at the goal from spinshot.
- The mechanical work of damping (L_{amr}) indicates the energy consumption at the moment of damping the landing during the execution of the technical procedure of throwing at the goal from spinshot.

As part of the analysis protocol of the spinshot goal throw, two variations of the jump throw were measured:

- Jump 1 (HTS – Handball Twist Shot) – the subject had to simulate the procedure of throwing at the goal from a spin with hitting the platform and landing on the ground. The purpose was to isolate the momentum part of the actual spinshot.
- Jump 2 (JHT – Jump Handball Twist Shot) – the subject had to perform the full spinshot throw at the goal, with swing and the ball in hand, landing on the ground. The goal was to measure the complete execution of the spinshot goal throw.

Fig. 4 Săritura 1 – HTS

Fig. 5 Săritura 2 - JHT

Data analysis and statistical processing

Statistical analyses were performed using the SPSS Statistics program (version 17; SPSS, Inc., Chicago, Il) with a significance level of 5% (significance accepted when $p < .05$). The measurements of the research variables were performed according to the analyzed jump (HTS or JHT) and the measurement time: at the beginning of the intervention program (M1) and at its end (M2). Descriptive statistics calculations were performed – average and standard deviation. After analyzing the distribution of recorded scores, averages were compared using appropriate tests.

RESULTS

As a result of performing the Shapiro-Wilk data distribution test, it emerged that all analyzed parameters presented a $p > 0.05$, thus being able to conclude that the data have a normal distribution.

In order to compare the averages of the variables recorded in the M1 and M2 time of the research for Jump 1 HTS (Table 1), paired t-tests were performed, the analysis showing the following:

For the variables FxImp and Tq variables, the paired t-tests identified significant differences between the mean scores recorded in the two moments of the measurements – (FxImp M1: M = -9.93, DS = 10.09 and FxImp_M2: M = 14.23, DS = 3.37; $t_{(12)} = -2.16$, p = 0.05); respectively Tq_M1: M = -1696.57, DS = 153.88 and Tq _M2: M = 2770.50, DS= 367.05; $t_{(12)} = 2.91$, p = 0.01);

In the TEx and FzImp, no statistically significant differences were identified between the averages from the moments M1 and M2 – (TEx M1: M = 1.16, DS = 0.09 and TEx M2: M = 1.19, DS = 0.05; $t_{(12)} = -0.35$, p = 0.73); (FzImp_M1: M = 961.65, DS= 58.51 and FzImp_M2: M = 1003.66, DS = 33.56; $t_{(12)} = 0.57$, p = 0.58); Also, for the variables, F_{amr}, L_{imp} $L_{amr,}$ P_{imp}, P_{amr}, , of HTS, no statistically significant differences were found.

Table 1. Paired t-test at HTS (N=13)

Variable	Unit	Means	STDEV	t	df	Sig. (p)	Effect Size (d)
TEx_M1	s	1.16	0.09	-0.35	12	0.73	0.20 / -.09
TEx_M2	s	1.19	0.05				
FzImp_M1	N*s	961.65	58.51	0.57	12	0.58	0.33 / .16
FzImp_M2	N*s	1003.66	33.56				
FxImp_M1	N*s	9.93	10.09	-2.16	12	0.05	1.24 / -.60
FxImp_M2	N*s	14.23	3.37				
Tq_M1	(10^{-2}) * N*m	1696.57	153.88	2.91	12	0.01	1.68 / .61

Tq_M2	(10^{-2}) * N*m	2770.50	367.05				
F_{amr}_M1	N	654.08	29.54	0.27	12	0.79	0.16 / .07
F_{amr}_M2	N	664.84	23.05				
P_{imp}_M1	W	113.75	33.45	0.04	12	0.97	0.02 / .01
P_{imp}_M2	W	116.05	40.53				
P_{amr}_M1	W	29078.67	1757.04	0.66	12	0.52	0.38 / .18
P_{amr}_M2	W	31307.09	2585.58				
L_{imp}_M1	J	20.44	10.49	1.70	12	0.12	0.98 / .47
L_{imp}_M2	J	2.10	0.80				
L_{amr}_M1	J	15302.83	1202.67	0.84	12	0.42	0.48 / .23
L_{amr}_M2	J	16766.51	992.67				

Note:
HTS= Handball Twist Shot; M1= initial measurements; M2=finale measurements; TEx= The execution time; Fzimp= The vertical impulse; Fximp= The anterior-posterior impulse; Tq= The torque; F_{amr}= The damping force; P_{imp}= Pushing power; P_{amr}= The damping power; $P_{imp=}$ mechanical work of pushing; L_{amr}As= mechanical work of damping

When comparing the averages of the variables recorded in moments M1 and M2 of the research for Jump 2 JHT – Jump Handball Twist Shot (Table 2) – Paired t-tests show us that:

For the variables TEx, FzImp, Tq, L_{amr}, P_{amr}, the paired t-tests identified significant differences between the mean scores recorded in the two moments of the measurements – (JHT_TEx_M1: M = 0.62, DS = 0.13 and JHT_TEx_M2: M = 1.15, SD = 0.10); $t_{(12)}$ = -2.88, p= 0.01); (JHT_L_{amr}_M1: M = 18139.65, DS = 1828.53 and JHT_L_{amr}_M2: M = 12206.62, DS = 688.27; $t_{(12)}$ = -2.70, p= 0.02); (JHT_Tq_M1: M = 855.54, SD = 492.76; and JHT_Tq_M2: M = 3205.39, SD = 367.36; $t_{(12)}$ = 3.35, p = 0.01); (JHT_L_{amr}_M1: M = 18139.65, DS = 1828.53) and JHT_L_{amr}_M2: M = 12206.62, DS = 688.27; $t_{(12)}$ = -2.70, p = 0.02); (JHT_Pamr_M1: M = -37156.11, DS = 3234.32 and JHT_P_{amr}_M2; M = 20944.87, DS = 1760.07; $t_{(12)}$ = -4.11, p = 0.00. In these variables the effect size is very large.

No statistically significant differences were observed between the means of: FxImp (JHT FxImp M1: M = 16.75, DS = 3.51 and JHT FxImp M2: M = 23.12, DS = 5.56; $t_{(12)}$ = 1.03, p = 0.32); F_{amr} ((JHT F_{amr} M1: M = 653.12, DS = 30.19 and JHT F_{amr} M2: M =.661.32, DS = 23.70; $t_{(12)}$ = 0.21, p = .0.84); P_{imp} variable (JHT P_{imp} M1: M = 86.28, DS = 27.25 and JHT P_{imp} M2 M = 39.78, DS = 9.09; $t_{(12)}$ = 1.85, p = .09). Also, no statistically significant differences were observed in the parameters L_{imp}, of JHT (JHT L_{imp} M1: M = 6.75, DS = 5.67 and JHT L_{imp} M2: M = 0.91, DS = 0.59; $t_{(12)}$ = 1.12, p = 0.28) (Table no. 2).

Table 2. Paired t-test at Jump Handball Twist Shot (N=13)

Variable	Unit	Means	STDEV	t	Df	Sig. (p)	Effect Size (d)
TEx_M1	s	0.62	0.13	-2.88	12	0.01	1.66 /.80
TEx_M2	s	1.15	0.10				
FzImp_M1	N*s	515.53	122.45	2.52	12	0.03	1.45 / .70
FzImp_M2	N*s	966.79	90.46				
FxImp_M1	N*s	16.75	3.51	1.03	12	0.32	0.59 / .37
FxImp_M2	N*s	23.12	5.56				
Tq_M1	(10^{-2}) * N*m	855.54	492.76	3.35	12	0.01	1.93 / .93
Tq_M2	(10^{-2}) * N*m	3205.39	367.36				
F_{amr}_M1	N	653.12	30.19	0.21	12	0.84	0.12 / .06
F_{amr}_M2	N	661.32	23.70				
P_{imp}_M1	W	86.28	27.25	1.85	12	0.09	1.06 / .51
P_{imp}_M2	W	39.78	9.09				
P_{amr}_M1	W	37156.11	3234.32	-4.11	12	0.00	2.37 / 1.14
P_{amr}_M2	W	20944.87	1760.07				
L_{imp}_M1	J	6.75	5.67	1.12	12	0.28	0.65 / .31
L_{imp}_M2	J	0.91	0.59				
L_{amr}_M1	J	18139.65	1828.53	-2.70	12	0.02	1.55 / .75
L_{amr}_M2	J	12206.62	688.27				

Note:
JHT= Jump Handball Twist Shot; M1= initial measurements; M2=finale measurements; TEx= The execution time; Fzimp= The vertical impulse; Fximp= The anterior-posterior impulse; Tq= The torque; F_{amr}= The damping force; P_{imp}= Pushing power; P_{amr}= The damping power; $P_{imp=}$ mechanical work of pushing; L_{amr}As= mechanical work of damping.

DISCUSSION

The results of this study showed us statistically significant differences for the parameters of the technical process without momentum (HTS), Fx_{Imp} (p = 0.05), Tq (p = 0.01), and regarding the realization of the complete technical process - with momentum (JHT) we have found statistically significant differences in the parameters TEx (p = 0.01), FzI_{mp} (p = 0.03), Tq (p = 0.01).

In this study, the development of the forces generated on the ground for the spinshot throw at the goal of handball players through exercises implemented in sports training was followed.

Considering that Gorostiaga (2006), Granados et al. (2007) and Saeterbakken et al. (2010) consider the execution time of technical procedures as an important aspect in achieving success in beach handball, in addition to muscle strength and coordination of body segments, it is necessary to interpret the results for this variable. Among the two types of jumps analyzed, HTS and JHT, a statistically significant difference was identified only in the second variant, which is closest to the form of the procedure used in beach handball. The increase in the average values of TEx between the initial and the final measurement can be interpreted by the possible influence of the exercises of correction and consolidation of the technical procedure.

Another interesting result to discuss is the evolution of the parameters FzImp and FxImp which showed differences between the two types of jumps measured. In the jump without momentum, the vertical impulse was not statistically significant, while in the case of performing the complete procedure, the forward impulse was not statistically significant. This state of affairs can be explained by the implicit difference in the execution of the procedure. Thus, the momentum generated in the case of JHT provides the necessary impulse to move the body of the subject after the detachment from the ground, in the direction of the throw. In the opposite case, when the HTS was performed, the subjects needed a higher value of the horizontal impulse, thus also increasing the statistical significance.

At the same time, for both FzImp and FxImp, the values increased between the initial and the final measurement, thus indicating the influence of the training program in the development of these parameters. The exercises in which the gymnastics trampoline was used led to the balancing of the subjects at the time of jumping, but also to the development of their orientation in space at the time of performing the spin in the air.

The research subjects were female handball players, at the junior level, and are familiar with the classic handball throws (jump, standing or running throw). There are studies that have highlighted by which technical methods of throwing at the goal the players achieve the highest efficiency. According to them, the running goal kick has an efficiency of 98%, followed by the jump goal kick with 98% efficiency (Fradet et al., 2004; Wagner & Muller, 2008; Wagner et al., 2011).

Regarding the Tq parameter, it can be seen how for both types of jumps the values increased between the initial and the final measurement. Given the fact that the procedure itself contains both a strong rotation movement and a twisting movement of the trunk before performing the jump, it is important to analyze the values of this parameter. The higher the general force torque (Tq), the faster it is possible to pass from the loading phase (twisting+rotating) to the pushing and detaching phase. In the context of beach handball, performing a correct procedure but more fluently in movement, can ensure an accuracy of completion in the game situation with phases that follow quickly. At the same time, the very high values recorded in the case of JHT at the final measurement, may indicate that the intervention program had a positive effect on the subjects by providing additional muscle power that can become valuable in the context of performing this procedure on sand in competitive conditions.

The exercises to imitate the execution of spins and semi-spins without diving (turns of 90 degrees and 180 degrees) had an important role in making the procedure as fast and efficient as possible in its complete form, decreasing the values of the mechanical work on damping (L_{amr}), achieving a more efficient movement from the point of view of the damping technique at the initial moment of the jump.

Another interesting situation identified following the analysis of the obtained data is that of the P_{imp} and P_{amr} parameters, which showed decreases during the JHT jump. This phenomenon can be explained by the nature of the exercises incorporated in the training program that were aimed at improving the technique and less at the pure development of motor qualities. At the same time, we should not forget the possible effect of the improvement of neuromuscular control on the execution of the technique between the two measurements. An increase in neuromuscular control causes a decrease in the mechanical work required to perform a movement, and implicitly a decrease in the power developed during execution.

CONCLUSIONS

In order to improve the execution of technical throw in the goal procedures, an appropriate training program can increase the parameters of ground forces in the game of beach handball. Our study identified that the exercises used determined an increase in the values of the anterior-posterior impulse, the force torque, the execution time and the vertical impulse, the most important parameters for the achievement of the technical procedure of the throw to the goal from spinshot in the beach handball.

Conflicts of interests
The authors declare that there is no conflict of interest.

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