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Exercises and sets of exercises diagnosing the ability to optimally use muscle strength – part II: upper limbs

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Abstract

The phenomenon of ability to optimally use the muscle strength (AOUMS) was defined in the most general terms by the author in the first work dedicated to this issue. In addition, the author presented in that publication the general assumptions and the method of measuring the AOUMS of the lower limbs. The aim of this paper is to recommend a simple set of exercises for diagnosing upper limbs AOUMS.

Diagnosing of upper limbs AOUMS (quasi-apparatus version): baseball throws (dominant hand first) in a relatively isolated posture (heels, buttocks and back pressed against the wall). The quality of isolated posture was controlled in such a way that the tested person must to press 4 sheets of paper against the wall with the muscles of the back and buttocks. The attempt was considered valid if the card or cards did not fall during the throw of the ball. The throw distance was determined using a measuring tape with an accuracy of 1 cm.

The other evaluation criteria are the same as when measuring AOUMS lower limbs, that means: the minimum set of diagnostic exercises for alternating eyes open – eyes covered must consist of six exercises, respectively one throw with the use of force according to the model: first throw 50% of the sense of maximum strength with open eyes; second throw between 5% to 45% of the feeling of this force with covered eyes; 65% to 95% – open eyes; 50% – covered eyes; 5% to 45% – eyes open; 65% to 95% – covered eyes; the series of six exercises ended with three trials with eyes open, each at 100% (the farthest throw was the frame of reference for measuring the conformity of each score to the model expressed in %).

The exposure model used as a function of force time (first with the dominant hand, then with the non-dominant hand) was identical to that for measuring the AOUMS of the lower limbs. Thus, combining both models (starting with measuring the AOUMS of the upper limbs according to the described methodology) is a simple, unique, low-cost method to measure this phenomenon in a complementary way. Such a conclusion is justified by the common truth that most of the basic motor activities of everyday life are performed by humans using the upper and lower limbs (apart from proportions).

Keywords: complementary way • methodology • 'power precision' • 'sensation energies'

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Motor skill – a skill for which the primary determinant of success is the quality of the movement that the performer produces [14].

Non-apparatus test – that motoric test (exercise endurance test) of the required reliability (accurate and reliable), which use does not require even the simplest instruments [15].

Quasi-apparatus test – can be conducted with simple instruments (a stopwatch, a ruler, a measuring tape, etc.) [15].

The Plate Tapping Test (Reaction Tap Test) – is a reaction test using an alternating wall tapping action which measures upper body reaction time, hand-eye quickness and coordination. Purpose: to assess the speed and the coordination of limb movement equipment required: table (adjustable height), yellow discs (20cm diameter), rectangle (30 x 20 cm), stopwatch; pre-test: Explain the test procedures to the subject. Obtain informed consent. Prepare forms and record basic information such as age, height, body weight, gender. See more details of pre-test procedures; procedure: If possible, the table height should be adjusted so that the subject is standing comfortably in front of the discs. The two yellow discs are placed with their centres 60 cm apart on the table. The rectangle is placed equidistant between both discs. The non-preferred hand is placed on the rectangle. The subject moves the preferred hand back and forth between the discs over the hand in the middle as quickly as possible. This action is repeated for 25 full cycles (50 taps); results: The time taken to complete 25 cycles is recorded. Perform the test twice and the best result is recorded.

Varimax method – allows minimizing the number of variables that have high factor loadings by orthogonal rotation; this simplifies the interpretation of factors.

Piórkowski apparatus – basic specification: Testing eye-hand coordination in a high time pressure situation; Has 10 buttons with a diameter of 45mm and red

INTRODUCTION

Presumption and assumption of diagnosing the ability to optimally use the muscle strength upper limbs are basically identical to those when studying the phenomenon of AOUMS lower limbs [1]. The difference is only in the other limbs, and these very circumstances imply the need for a different method in the motor sense, but also in the sense of the accessories used (baseball and measuring tape). Therefore, this set of exercises qualifies in the sense of the way measurements are made to the category of quasi-apparatus test (although formally it is not a test but still a 'set of exercises' with a clearly defined purpose). In this work I even recommend the same '2 × 160 UMS' (UMS – used muscle strength) however, first applied to diagnose dominant hand, then non dominant hand.

It is an invariable assumption that any researcher (research team) can use any set of exercises. However, in order to compare the influence of different factors either internal (the state of the body during sleep deprivation, illness that does not exclude the ability to perform these exercises etc.) or external (quality of lighting, noise, duration of homeostatic disruptors, etc.) and compare the results with other circumstances, it is necessary to use an identical set of exercises.

The aim of this paper is to recommend a simple set of exercises for diagnosing upper limbs AOUMS

Quasi-apparatus method of estimating AOUMS of the upper limbs

"Diagnostic Exercise Arrangement": model-exercise '2 × 160 UMS' (UMS – used muscle strength). Assumption of this model is to use 160% of muscle force twice each, three times with eyes open, three times with eyes covered (6 exercises in total) in an order known only to the examiner, alternating eyes open, eyes covered (**bold letters** in the UMS model described below).

Motor criteria: baseball throws from a relatively isolated standing posture (heels, buttocks and back pressed against the wall), the V finger of the hand that holds the ball must adhere to the chin, and the forearm parallel to the ground). The quality of isolated posture was controlled in such a way that the tested person must to press 4 sheets of paper against the wall with the muscles of the back and buttocks (Photo 1). The attempt was considered valid if the card or cards did not fall during the throw of the baseball. The throw distance was determined using a measuring tape with an accuracy of 1 cm (measuring from the wall to the central point of contact between the baseball and the ground).

The other evaluation criteria are the same as when measuring AOUMS lower limbs [1], that means: the minimum set of diagnostic exercises for alternating eyes open – eyes covered (preferably using blacked out goggles) must consist of six exercises, respectively one throw with the use of force according to the model: first throw 50% of the sense of maximum strength with open eyes; second throw between 5% to 45% of the feeling of this force with covered eyes; 65% to 95% – open eyes; 50% – covered eyes; 5% to 45% – eyes open; 65% to 95% – covered eyes; the series of six exercises ended with three trials with eyes open, each at 100%. Estimation of maximum force is based on performing the last three baseball throws with eyes open with a sense of the greatest energy exposure (each throw separated by about a 20-second pause). The farthest throw is the frame of reference for measuring the conformity of each score to the model expressed in %.

The UMS model used: 50%; **25%**; 75%; **50%**; 35%; **85%**; three times 100%.

Photo 1. Posture standing before baseball throws (without and with goggles) while estimating AOUMS of the upper limbs.

Organizational criteria: After declaring that the person understands the tasks, he or she assumes the starting posture (Photo 1) and, after the command "READY," performs successive throws according to the accepted model (but known only to the researcher), first the dominant hand, then the non-dominant hand.

The estimated compliance or error (in %) is the result of, first, determining the UMS value during the evaluated test (dividing the raw result of that test by the raw maximum result), and then comparing the performance (that is, this result with the model). An error-free result is documented with an "x" symbol in a special test sheet (appendix: *baseball throws from standing posture: dominant hand/non dominant hand – select*), while the use of excessive force is documented with a "+" symbol placed after the recorded result, and in the case of a force deficiency with a "–" symbol.

The index of the quality of muscle force use (AOUMS Index) in relation to the benchmark (model) value is the proportion of exercises whose error in relation to the model value is no greater than 5% to the number of exercises of a given diagnostic system. In the model used (for each hand separately), there are 6 exercises in total (3 with eyes open and with eyes covered). Thus, the AOUMS Index for the 6 exercises (expressed by the ratio index): very high 1 or 0.83; high 0.667; average 0.50; low 0.33; very low 0.167; inadequate 0. Absolute conformity of the exercises performed to the model or with errors of less than one percent would indicate an outstanding level of AOUMS and is documented by the index 1P.

A version of estimating AOUMS of the upper limbs from a sitting posture

There are many circumstances that justify measuring the **A**OUMS of the upper limbs of a person who sits on a chair (a piece of furniture commonly used in daily activities not excluding professional work). It is not necessary to use chairs with a standardized height. On the contrary, it would rather be advisable to test a person using a chair that he or she uses in his or her professional work or when he or she uses a computer or other item (such as practicing piano playing) at home. In that case, comfort should be provided for the hand that is doing the throwing, and attention should be paid to the equal support of the legs while sitting (Photo 2).

METHODOLOGICAL NOTES, RECOMMENDATIONS

Twenty years ago, Anna Krzak-Krzyżanowska [2] used a very simple method to measure 'sensation energies' (a term not found in specialized dictionaries of sport science and medicine, it comes from a free translation from Polish – 'czucie siły') during tests of the motor efficiency: 94 soldiers (out of 303) matched in pairs according to the similarity of measured motor abilities and somatic characteristics (47 in paratroopers and communications soldiers each). Arbitrarily, she took as the test of 'sensation energies' the throwing of a medicine ball at a distance of 50% of the result of a previously performed throwing attempt at the farthest possible distance. Although the author does not articulate it explicitly, the real indicator of 'sensation energies' is the correspondence of the result to the model, or a difference that may indicate either excessive use of muscle strength, or insufficient use (i.e., the proportion involved, which would sensibly be expressed in % denoted by the symbols „+" or „–"). Unfortunately, such a secondary calculation can only be made by a person interested in the results of this work, since the author uses raw scores (cm).

In my opinion, a secondary analysis of part of the results of that study is more interesting, as it indirectly shows the diagnostic perspective of the application of both AOUMS methods

Photo 2. Posture in front of baseball throws right hand (without and with goggles) while estimating AOUMS of the upper limbs (version sitting on a chair).

indicator lights; Operation mode: **forced/imposed;** The following test parameters can be set: rate: 30, 40, 50, 60, 75, 93, 107, 125 and 150/min; Test time: from 10 to 150 seconds.

Endurance training – *noun* exercises designed to increase an athlete's level of aerobic fitness [16].

Power training – ***noun*** intense training that emphasises proper form [16].

Counterproductive – from praxeological perspective certain action can be: productive – non-productive – counterproductive – neutral. The action is **counterproductive** when a doer achieved goal opposite than intended [17, p. 220].

Health-related training – seems to be a well-chosen one for the description of general activities which are undertaken either for the purpose of health maintenance, its improvement or restoration and also for the purpose of limiting the effects of involutional changes in the elderly [18, p. 180].

Health-related fitness – the components of health-related fitness involve cardiovascular fitness, muscular strength and endurance, flexibility, and body composition that helps you to stay healthy.

APA – Adapted Physical Activity.

(non-apparatus and quasi-apparatus) in health promotion and survival ability, in prevention, in therapy and in rehabilitation (that is, after prior clinical intervention). As the factor analysis showed, prior to the start of military training among the 59.75% variance of the common empirical variables that characterized soldiers' motor fitness, the 'sensation energies' index (0.47), together with results using Piórkowski apparatus, i.e., time (0.78) and errors (0.71), explained 15.82% of the variance. Named by the author as the 'spatial orientation factor,' it gave way only to the 'limb movement frequency factor' (17.49% of the explained variance – with a higher contribution of *tapping upper limb* (see glossary), 0.86, than, *lower limb tapping* 0.76). Even after six months of military training, there was a significant decomposition of these relationships. After applying the varimax rotation (see glossary), the factor that had the highest contribution (26.56%) in explaining the variance of the empirical variables characterizing soldiers' motor fitness was power identified with the medical ball throw at the maximum possible distance (0.72) and with the results of two EUROFIT trials [3]: *standing broad jump* (0.85); *bent arm hang* (0.69). Meanwhile, the 'sensation energies' score was the second of two significant (0.66) components of the factor explaining only 9.71% of the variance – the first being the *flamingo balance test* score (−0.76) [2]. Thus, these empirical data provide evidence that military training was dominated by methods and measures that stimulate muscle strength, but depleting 'sensation energies'.

Tadeusz Stefaniak [4] studied the same phenomenon, but called 'power precision' a few years later using more sophisticated laboratory methods. Like Krzak-Krzyżanowska [2], he came out with the enthymematic assumption that using 50% muscle strength a sufficient (accurate) criterion for diagnosing the same phenomenon from the intersection of physiology, kinesiology, neurology and psychology in relation to different circumstances. Stefaniak during randomized research of the 'power precision' phenomenon of combat sports athletes (n = 202 and control group n = 67 physical education students) used highly specialized measuring equipment. He first determined the maximum values of force (Fmax), then in various experimental conditions (before warm-up, after warm-up, after training) the recovery of 50% of Fmax. During the in-depth analysis, Stefaniak reports that 96.81% of the male respondents (n = 182) were right-handed and at the same time their right leg was dominant. Among the women surveyed, 94.81% were right-handed (an obvious editorial error [4] – it was probably either 93.83% or 95.6%).

The authors of these experiments ignored two facts. First, during military operations, when hand-to-hand combat is the necessary means of achieving an objective, the use of even just 50% Fmax can be counterproductive. For example, striking a grappled captive with such force can deprive him of life, or maim him in such a way that he cannot communicate through speech. Second, combat sports athletes are not only desirable candidates for soldiers of any formation. Each combat sports are at the same time defence art [5], so the ability to differentiate muscle strength should be one of the equal goals of combat sports training. During necessary defence, exceeding the criterion of force used ends with legal consequences [6].

The results of Stefaniak's experiment provide evidence that the specific effect of training some combat sports is precisely to shape the ability to optimally use the muscle strength (regardless of whether coaches are aware of influencing this phenomenon, after all, the paradigm of the necessary effectiveness of sports training is dominated by the principle of maximizing individual motor skill). The lowest dispersion of the result of using 50% Fmax was found after the warm-up among kick-boxing athletes and judokas, the highest among the boxers and students (control group). However, both before the warm-up (when the body is not sufficiently stimulated for motor activity) and after the 82-minute workout, which was a combining endurance training with power training (when stimuli, admittedly of identical content, same duration and external load, set at 20% of individual capacity, and so vary the biological effect due to genetic reasons, current motivation, etc.) the magnitude of errors – admittedly partially differentiating athletes depending on the sport – exceeded the results after the warm-up. Perhaps this is an inevitable cost, especially of the effects observed immediately after sports training, but this model should be avoided during health related training, or APA – which is the same (after all, they are just different names for the same phenomenon). What's more, in the scientific literature and works promoting healthy physical activity, the term is also used 'health-related fitness'.

The view expressed in the last sentence may be controversial, especially among proponents of any success, regardless of the price (in this case measured by negative health effects). However, if we proceed from the assumption, that the most important message of daily, multi-hour, varied motor activity is concern for personal safety, then training aimed at enhancing this safety should be based on the principle of optimizing methods and means, not maximizing them (this does not mean that maximal stimuli should be shunned). This assumption also applies to many competitions that require even hours of engagement of one's motor skills (with selective, alternating or combined exposure of conditioning and coordination abilities), where one of the conditions for success, but also for avoiding injury or even death, is AOUMS.

Thus, the proposed, not so much AOUMS models – this one and in a previous paper [1] – but the idea and methodological basis for studying this phenomenon as a function of time (filled with various activities and, in extreme cases, periodic physical inactivity) can be applied to many areas of human activity. A simple example is the diverse motor activity of musicians. Both limbs are used by the drummer, pianist, organist, harpist. Both hands, but in different ways, a violinist, guitarist, contrabassist, etc. However, the solo violinist does his work standing, so it is reasonable to use both AOUMS models (for diagnosis of upper limbs and lower limbs) or new tools, but based on this methodological basis. A violinist, as well as another orchestral or chamber musician, performs their work sitting, so a version of AOUMS using a chair may be applicable.

The application of the AOUMS methodology in the field of sports, in military training, in the training of rescue formations, etc., is not only related to the possibility of increasing the capability of starting, intervention, rescue, etc., but, above all, to the fulfilment of the preventive mission of rational training. The advancement of diagnostics and, consequently, the possibility of achieving the most important goals at the highest level can be provided by compilations of 'sets of exercises' of AOUMS with other, often innovative, methods and tools that measure other trainable phenomena, but also those that may pose a real danger. Moreover, when new measures are used in a particular area of human activity (sports, physiotherapy, rehabilitation, etc.), their effectiveness should be analysed in a complementary manner. A good example is the possibility of continuing research on the support of American football training through the use of kettlebell exercises [7], after all, the effectiveness of athletes in this sport is related to the level of upper limb and lower limb AOUMS. However, I see the widest applicability of AOUMS methodology and tools in the areas of prevention, therapy and rehabilitation in the broadest sense. Many reports appear reporting on the effects of Chinese therapeutic exercises that also include elements that expand a person's defensive capabilities [e.g. 8-13], but the aspect of measuring the ability to optimally use the muscle strength is overlooked in the recommendations that talk about the tools used and the phenomena diagnosed.

CONCLUSIONS

The exposure model used as a function of force time (first with the dominant hand, then with the non-dominant hand) was identical to that for measuring the AOUMS of the lower limbs. Thus, combining both models (starting with measuring the AOUMS of the upper limbs according to the described methodology) is a simple, unique, low-cost method to measure this phenomenon in a complementary way. Such a conclusion is justified by the common truth that most of the basic motor activities of everyday life are performed by humans using the upper and lower limbs (apart from proportions).

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The ability to optimally use the muscle strength AOUMS of the upper limbs
(baseball throws from standing posture: **dominant hand**/non dominant hand – *select*)
/basic system of diagnostic exercises: 2 x 3 alternately open and covered eyes/

Person …………………………………..………………. place ………..……… date …..….… time: from …... to ……

Model of using muscle strength as a function of time [%] (CE: covered eyes)										Total results in lines [%] without 100%
		CE		CE		CE	open eyes			
	50	25	75	50	35	85	**100**	**100**	**100**	
Results	**the raw result: centimetres** (with an accuracy of 1 cm)									
raw										
%										

Profile AOUMS [accuracy in %]

Criteria for three ranges of use of muscle strength (UMS)	open eyes					covered eyes					**Index AOUMS**[x]	
	the range of UMS [%]					the range of UMS [%]					score 0.00 or difference model ↔ execution ≤1% or ≤5%	
	comparison		difference model ↔ execution			comparison		difference model ↔ execution				
	model	execution	+	–	0**	model	execution	+	–	0**	**open eyes (n)**	**covered eyes (n)**
5 to 45%	35					25						
50%	**50**					**50**						
55 to 95%	75					85						
Sum	**160**					**160**					$\frac{n+n}{6} =$	
Difference	*		sum of differences			*		sum of differences				

*put „+" *or* „–" after the result; **put an X in the appropriate line

Model of using muscle strength as a function of time (×) and execution (○)

%	**50**	**25**	**75**	**50**	**35**	**85**	**100**	**100**	**100**	**%**
100							x	x	x	100
90										90
80						×				80
70			×							70
60										60
50	x			x						50
40										40
30					×					30
20		×								20
10										10
Difference [%]*										

HR 6 second									^	^^	^^^
Motivation 1 to 10 points	#						##		##	###	

HR ^immediately after the last 100% throw, ^^60 seconds later, ^^^120 seconds later (at the discretion of the researcher during the throws)
Motivation: #before the first throw, ##before the first and third throw 100%, ###after the HR measurement after the last throw 100% (assuming the ability to continue throws)

[x]**Index AOUMS:** perfect 1P (each score 0.00); very high 1 or 0.83; high 0.667; average 0.50; low 0.33; very low 0.167; insufficient 0

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