



USING THE BEEP TEST AS AN ALTERNATIVE TO MEASURING THE MILITARY'S AEROBIC CAPACITY

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Physical training in the Romanian Army generally keeps up with the main line of training of other NATO states, having the same training principles and fundamental ideas on the positive effects that the military's motor capacity can have on the development of military actions and successful fulfillment of entrusted missions. At the same time, there is an obvious need to develop (or revise the existing ones) in the Romanian Army modern tools (concepts, methods, regulations and manuals specific to military physical education) to form the basis for training and training of fighters, as there are in strong armies, recognized for their emphasis on the physical training of the military..

Keywords: Beep test; endurance running; maximum aerobic capacity; physical training.

During the process of measuring the performance of the military, several decisions must be made regarding the choice of methods used and the interpretation of the data collected. A wide range of tools are used to assess skills in the cognitive (knowledge assimilation and intellectual capacity building), affective (attitude, belief and feeling formation) and psychomotor (motor and practical behavior training) areas. First, it is very important to properly determine the areas in which the educational objectives to be set are planned. Second, specific objectives need to be developed and appropriate tests selected that can measure and highlight in a real and valid way the objectives set. Finally, when the data are collected, the conclusions of the evaluation can become norms or reference criteria.

"Evaluation in military physical education involves checking, assessing and grading those tested. Military verification involves the application of techniques to know the changes produced by participation in training, based on predetermined objectives, and involves physical effort as a result of taking a sports test. The accuracy of the verification is determined by the quality of the instruments used, by the way in which they are applied and by the knowledge necessary for their objective application. The assessment represents the value judgment of the results, a reflection of the effort made by the military in training. It is all

the more objective as the evaluation criteria are more accurate and can be measured and quantified accurately. Scoring is the activity of transforming the assessment of results into grades (in military educational institutions) and grades (admitted or rejected - for training units)"¹.

The armed forces are constantly changing, with increasingly sophisticated equipment leading to strict specialization. Different requests are the reason why, in addition to the usual (basic) tests, there should probably be different special assessment and recruitment tests. Physical performance testing should be a natural part of all training, because its results measure the improvement of physical condition, predict future performance, signal weaknesses, allow the evaluation of the quality of the training program and, above all, motivate continuous training.

Beep Test

The "Beep" endurance test, frequently used to determine the maximum aerobic capacity (VO₂ max), can be found in the literature under several names, such as: "Multistage Fitness Test" (MSFT), "Leger test", "Pacer test" or "20 meters shuttle run test". Regardless of its name, this test, extremely simple and conclusive, can perform a standardized assessment of the level of physical training of the military, estimating what is the highest level of oxygen consumption reached by them, in maximum effort.

The great advantage of this test is that it gives you an objective measurement that will show you if your fitness level is what you need. On top of

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that, it is also very simple, without the need for any sophisticated equipment. If you can mark a straight line on a flat surface over a distance of 20 meters and if you can download an mp3 file or use an application on a mobile phone, then in about 10-15 minutes you will even be able to self-evaluate.

The Beep test was originally designed in 1983 by Professor Luc Léger, a PhD degree holder in physical education, of the University of Montreal² in order to test a person's fitness level. Subsequently, in 1988, the test was republished in its current form (after small adjustments were made) in the European Journal of Applied Physiology.

One of the important components of the military's physical training is endurance (aerobic exercise capacity or cardio-respiratory endurance). When it comes to the physical endurance of the military, we must inevitably determine what is their maximum aerobic capacity (VO_2 max), well the highest level of oxygen consumption reached in maximum effort.

The main purpose of the Beep test is to measure aerobic capacity (cardio-respiratory fitness), being a good predictor of the maximum amount of oxygen that can be used by a serviceman. It has an upper limit on the transport and use of oxygen in the body, and this rate of oxygen consumption is proportional to the performance obtained in aerobic exercise capacity tests (performance improves when VO_2 max increases)³.

To accurately measure and determine the value of VO_2 max (a cardio-metabolic test), you must

VO_2 max is measured in milliliters of oxygen, per kilogram of body weight, per minute (ml/kg/min), and the values recorded in women compared to men are lower, their difference being between 10 - 25%, depending on the level of training physical. Also, these values decrease with age and increase the percentage of fat, a situation in which the ability of the cardiovascular system to deliver oxygen to the tissues is no longer influenced too much by the level of training. Numerous studies⁴ have shown that the value of VO_2 max increases in the case of intense and short workouts, in which to vary the intensity of the effort (such as Fartlek type workouts⁵).

Taking the Beep test as a model, over time various similar versions have been published online, so we must be careful when installing the program in order to select the original one⁶. This test is one that involves maximum effort, which requires an above average physical condition, not recommended for people who play sports as a means of recreation, who have health problems, joint / muscle injuries or a low level of fitness.

The Beep test is used by various sports organizations or federations as an entry test or as a periodic verification test. Currently, this form of testing is used by the armies of the following NATO member countries, such as the USA (when admitting all categories of personnel into the system), Canada (only for military students and special forces) and France (for the Foreign Legion), United Kingdom, Norway, Denmark, for the purpose of periodic

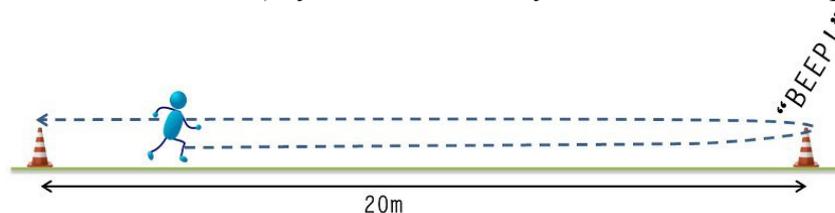


Figure 1 Running diagram for the "Beep" endurance test

be connected by specific devices to a treadmill in clinical laboratory conditions and wear a mask that can accurately monitor how much oxygen you use during the effort. Given that military units do not have such a facility, in order to estimate the aerobic capacity of the military, evaluation tests on endurance running on flat or varied terrain are used. Instead, under some conditions, a better alternative would be to use the Beep test, which makes testing the VO_2 max level a bit simpler and easier.

annual testing or for admission to the system. In various forms the test is also used by other countries in the alliance (such as Germany, Poland or Greece) or outside the alliance (Sweden – only for officers, Australia, New Zealand, etc.).

Simply put, the Beep test involves a continuous run (back and forth) between two parallel lines, located 20 meters apart, synchronizing the pace of movement with an audio recording that emits beep-like beeps (hence the name test) at regular intervals.



Before the assessment begins, the military must stand behind one of the lines and listen to the latest audio instructions recorded or processed by

to increase their speed. The evaluation will end when they are no longer able to keep up with the recording.

Table no. 1

BEEP TEST PARAMETERS

Level	Number of rounds	Number of cumulative rounds	Speed of running (km/h)	Travel time / round	Total time / level (sec)	Total cumulative time (min:sec)	Traveled distance / level (meters)	Traveled cumulative distance (meters)
1	7	7	8.5	9.01	63.07	1:03	140	140
2	8	15	9.0	8.00	64.00	2:07	160	300
3	8	23	9.5	7.58	60.63	3:08	160	460
4	9	32	10.0	7.20	64.80	4:12	180	640
5	9	41	10.5	6.86	61.71	5:14	180	820
6	10	51	11.0	6.55	65.45	6:20	200	1020
7	10	61	11.5	6.26	62.61	7:22	200	1220
8	11	72	12.0	6.00	66.00	8:28	220	1440
9	11	83	12.5	5.76	63.36	9:32	220	1660
10	11	94	13.0	5.54	60.92	10:32	220	1880
11	12	106	13.5	5.33	64.00	11:36	240	2120
12	12	118	14.0	5.14	61.71	12:38	240	2360
13	13	131	14.5	4.97	64.55	13:43	260	2620
14	13	144	15.0	4.80	62.40	14:45	260	2880
15	13	157	15.5	4.65	60.39	15:46	260	3140
16	14	171	16.0	4.50	63.00	16:49	280	3420
17	14	185	16.5	4.36	61.09	17:50	280	3700
18	15	200	17.0	4.24	63.53	18:53	300	4000
19	15	215	17.5	4.11	61.71	19:55	300	4300
20	16	231	18.0	4.00	64.00	20:59	320	4620
21	16	247	18.5	3.89	62.27	22:01	320	4940

the task leader regarding the conduct of the test. At the command "Attention! - Beep! - Start!" (English: "Ready! - Beep! - Start level 1-1!"),⁷ the player runs to the opposite line. At first, the pace of movement is quite slow, the serviceman continuing to run between the two lines, returning only when he hears the Beep. After about a minute (the duration of a level is between 60 - 66 seconds), another type of sound (a triple Beep with different tones) indicates the transition to the next level which involves an increase in running speed (so there will be more beeps to be heard). As the test continues, the interval between the beeps decreases with each pass to a higher level, forcing the military

The distance of 20 meters (a turn) is considered to be covered regularly if the serviceman reaches the opposite line with at least one foot (putting the sole on the line) before the Beep sound goes off. At this time, the resumption of the run must be done only after the beep is heard, the departure before it being forbidden and sanctioned with a warning. The same is true if the line is not touched before the Beep. In this situation, the examinee must continue running towards the target line, reach it and try to re-enter the required tempo. In both cases, the test is stopped if, after receiving a warning, the serviceman fails (twice in a row) to fall into the cadence of the beeps.



The score obtained by an examinee is represented by the level and number of complete laps (20 meters) completed regularly, before he can no longer keep up with the registration. Consisting of 21 levels, the Beep test starts with a speed of 8.5 km/h, and after each level (which lasts just over a minute), it increases by 0.5 km/h (according to the parameters mentioned in table 1). If you manage to reach the end of the test, it means that 22 minutes and a second have passed, you have covered the distance of 4.94 km (running in the last level with a speed of 18.5 km/h) and you should call Guinness World Records to record your performance, because no one in the world has managed this so far.

The world record for most simultaneous participants in a Beep test was set on the morning of December 14, 2017, by 941 cadets of the Military College in Harrogate (UK)⁸.

The Beep endurance test has several advantages over other methods of assessing the level of aerobic capacity of the military (such as classic endurance running or running in various terrains), such as⁹:

- it is easy to manage and does not require the possession of sophisticated equipment, just a program downloaded for free from many websites and installed on your computer, tablet or Smartphone and a portable speaker with Bluetooth or some headphones. The size of the file in MP3 format is about 5 MB and it only takes a few seconds to download;

- very little space is needed, any flat ground without obstacles, marked with milestones, being very good (at least one corridor with a length of 20 meters and a width of one meter for each serviceman, meaning 20 m²);

- it is not necessary to perform a long heating, because the test itself starts very easily, after which it gradually becomes faster and faster (we can consider that the first three levels represent a period of built-in heating). Ideally, without exaggeration, a warm-up should be performed before the start of the test, lasting about 5-10 minutes, comprising an easy run, some dynamic stretching exercises and short runs with changes of direction and rhythm;

- it can be executed individually or in groups (see the world record of 941 participants at the same time), as long as there is a flat surface with a length of 20 meters and a width of 1 meter for each serviceman;

- can have a social character by the fact that the servicemen who perform the test in a series, during

the first levels, when the pace is low, can talk to each other. Then, as the intensity increases, they will become quieter and quieter, and after they stop or are eliminated, they can continue to encourage those who have not yet completed the test;

- there is the possibility of following all participants, by evaluators or spectators, throughout the test;

- regardless of the level of physical training of the military, they will always be close, without moving away from each other more than a few meters;

- it has been tested and researched very well, there are numerous studies that demonstrate the accuracy of the results obtained¹⁰;

- it develops in the military other motor qualities in addition to aerobic endurance, such as dexterity (coordination of movements) or speed (reaction, acceleration);

- it can also be used in the activity "Sport for all" (complementary part of the training process) by a large number of servicemen, in different forms: to measure the level of fitness (especially endurance) as an alternative to assessment, traveled in the form of a competition to compare the result obtained with that of colleagues, to set a new personal record, per unit or army, or simply to attract staff from the unit to engage in physical activity in an organized manner.

As a matter of fact, in the case of the Beep test, the servicemen who are more trained will finish the last test (as opposed to running endurance on a set distance when they finished first), giving the other participants the opportunity to applaud them at the end for their performance.

Regarding the disadvantages of the Beep test, we can list the following aspects:

- in order to record a genuine result, the level of motivation of the military must be high (the performance achieved during training is not always the real one, because the level of motivation is lower than during a formal evaluation);

- in order to obtain a better score, the technique of turning and running in a straight line (on a trajectory perpendicular to the two lines drawn on the ground) must be learned, strengthened and perfected. It is enough to tread the line with one foot, it is not necessary to pass the body (total or partial) along the line. Any step performed along the line or turn that describes the shape of the



letter U, theoretically, represents unnecessary energy consumption and is added to the total distance traveled at the end. A recommendation would be to use the legs alternately to reach the two lines, which helps to distribute the pushing effort and to offer a concern to the military to keep their minds occupied. As a technique for performing turns, it is recommended that you perform a lateral turn of the body on the last two steps before the line, place the sole of the front foot (as far as possible) parallel to the line, and place the other leg straight (as far as possible), with the tip towards the next line, ready to push into the ground and move the body in this direction. The importance of making correct returns to the Beep test is the same as the significance of a return in a swimming test.

- if practiced outdoors, extrinsic factors such as atmospheric conditions (extreme temperature, wind, rain, etc.) may affect the result obtained.

In the beginning, when they first get in touch with this test, most examinees will get scores below their own aerobic possibilities due to psychological limitations. At some point, when the test starts to get difficult and your body gets tired and tells you it wants to give up, you should not give up easily. When this happens, you have to make up your mind to play the role of being relentless, being surprising how far an attitude like "I will not stop yet, I'm trying to take another turn" can take you. In order to give you extra motivation not to give up in the difficult moments during the test, it may be useful to have a colleague on your side to encourage you. At the same time, you need to focus your thoughts on something else, avoiding focusing on how difficult the test is.

When the test is performed in a group, it is tempting to focus too much on the evolutions of the other participants, ending up formulating in your mind a lot of useless questions and comparisons, such as: "should I keep up?", "Am I faster than him?", "they don't seem as tired as I feel". Do not try to run at the pace of another colleague, but keep the pace of the beep on the recording. Usually, among the first servicemen to give up earlier (stop) are those who run the fastest at first. It is advisable to save energy for higher levels, and at the beginning to use an easy run.

Implementation of the Beep Test in the periodic verification of the military

Currently, the assessment of the level of physical training for military personnel is mandatory twice a year by taking a physical test consisting of three tests (floats, abs and running distances between 1000 m - 3000 m, depending on gender, group age and type of military unit / subunit / structure)¹¹. Endurance running is performed inside military units on makeshift routes or using athletics tracks in the few units that have a proper sports base. At first glance, the test seems relatively easy to administer, requiring only the measurement and marking of a route, the possession of a timer and the presence of trained staff to help coordinate and note the performance of participants. However, it is not always possible to perform this test under acceptable conditions, due to restrictions/constraints/limitations imposed by the military environment, such as:

- establishing an inadequate route, running on a hard surface (concrete, asphalt, cubic stone, gravel, frozen ground, etc.) that can cause serious injuries over time to anatomical structures (ligaments, joints, tendons, muscles);

- lack of security and safety measures for military personnel carrying out physical activities in military bases in theaters of operations, during participation in NATO missions and operations;

- lack of space to establish a running route (on board ships, in small military units as a surface – military centers, military museums, military hospitals, etc. – or in those located in mountainous areas facing the lack of land "on as flat as possible");

- the impact of unfavorable environmental conditions for a long period of time (heat wave, frost, storm, etc.).

Given all these limitations and the fact that more and more non-NATO armies are developing their information and communication technology by creating programs for military surveillance using satellites/drones (which can monitor the movement of enemy troops, including their physical training), I believe that an alternative way to assess the resistance of the military to be used by the Romanian armed forces could be the Beep test.

Both the classic endurance running included, at this moment, in the half-yearly check of the level of physical training of the Romanian Army servicemen, and the Beep test proved to be good

predictors of the maximum oxygen absorption and, therefore, it estimates very well aerobic performance. The correlation between the performances obtained by the military in both tests was established by conducting a study respecting the principles of scientific research. Partial results were published in my own doctoral thesis¹², and I continued my research over the next three years by collecting and monitoring the performance obtained (in endurance running and the Beep test) by over 500 military students and active military personnel (included in

- the score achieved in the interval 3/5 - 6/9 (distance covered between 400 - 1000 meters), for each additional lap (20 meters) 2 points are awarded;

- the score achieved in the interval 6/9 – 11/6 (distance covered between 1000 - 2000 meters), for each additional lap (of 20 meters) 1 point is awarded.

The optimization of the system for evaluating the level of physical training of the military in the Romanian Army can be done in a first phase by

Table no. 2

**EVALUATION OF THE PERFORMANCE OBTAINED IN THE BEEP TEST
(PROPOSAL AS AN ALTERNATIVE TO THE ENDURANCE RUNNING TEST)**

Beep Test		Age (years old) / gender (M - masculine, F - feminine)									
		18 - 25		25 - 35		35 - 45		45 - 55		Over 55	
Score obtained (level / rounds)	Traveled distance	M	F	M	F	M	F	M	F	M	F
3 / 5	400 m	--	--	--	--	--	--	--	--	--	50
4 / 2	500 m	--	--	--	--	--	--	--	50	--	60
4 / 7	600 m	--	--	--	--	--	50	--	60	50	70
5 / 3	700 m	--	--	--	50	--	60	50	70	60	80
5 / 8	800 m	--	50	--	60	50	70	60	80	70	90
6 / 4	900 m	--	60	50	70	60	80	70	90	80	100
6 / 9	1000 m	50	70	60	80	70	90	80	100	90	--
7 / 9	1200 m	60	80	70	90	80	100	90	--	100	--
8 / 9	1400 m	70	90	80	100	90	--	100	--	--	--
9 / 8	1600 m	80	100	90	--	100	--	--	--	--	--
10 / 7	1800 m	90	--	100	--	--	--	--	--	--	--
11 / 6	2000 m	100	--	--	--	--	--	--	--	--	--

all age groups), thus allowing the extension of the degree of analysis to a complex level, and the results being much closer to objectivity. In this regard, we have developed a summary table (Table no. 2) which shows us the minimum scales (marked with 50 points) that must be met (depending on age and gender) for the military to be declared "admitted".

At the same time, we extended the research to the situation where the assessment must be completed by awarding grades (in the case of military students, who usually fall into the age group between 18 and 25 years). For example: a male military student who scored 10/7 on the Beep test will be awarded a grade of 9 – the equivalent of 90 points. Note that:

implementing simple measures, which will manage more efficiently the instructive-educational process in the field of military physical education, as follows:

- reduction of the number of age groups (from 7 to at most 5 – according to Table no. 2);
- awarding grades or a score (for all tests in the test) to prevent the military from stopping execution when they reach the minimum scale and pass it in the annual service marks;
- equalization of the running distance at the endurance test with the maintenance of different scales depending on gender and age;
- the introduction of alternative endurance running tests that also assess the aerobic endurance



of the military, such as the Beep test, rowing on an ergometer, cycling on a fitness bike, running on a treadmill, swimming in a swimming pool, etc. ;

- the introduction of control tests or exercises to replace the current floats and abs, and to have more applicability on the battlefield (see FORCE Evaluation in the Canadian Army or Army Combat Fitness Test in the US Army).

In 2017, Dr. Stefan Kolimechkov, a coach who worked at the Elite Gymnastics Academy in London, along with several colleagues from the National Sports Academy in Sofia developed a computer software program called Beep Shuttle, created specifically to administer the data provided following the application of the Beep test. Consisting of two applications (for children / adolescents and adults) this program displays in real time all the parameters of the test (mentioned in Table no. 1), calculates VO₂ max (maximum aerobic capacity) according to the characteristics of those evaluated (age, gender, height, weight) and evaluates the results obtained by awarding grades based on international standards published by the American College of Sports Medicine¹³.

If the Beep Test is going to be used in the Romanian Army as an alternative option for measuring the aerobic capacity of the military, the Beep Shuttle program can be taken over and adapted so that specialists in the field of military physical education can use it in the military evaluation process.

Conclusions

This test designed by Luc Léger is one of the most popular forms of assessing the level of physical training of individuals, their physical and mental endurance. In addition to the fact that it tests your basic physical qualities, the Beep test also highlights some character traits such as the will to fight continuously and not to give up in difficult moments from a physical point of view. For someone who is part of the military system (or wants to be part of it) it is not exactly recommended that he simply give up due to fatigue, during a challenging situation. The military must show determination and courage, not show weaknesses and be able to perform in difficult environments or in extreme conditions. The Beep test will push you to the limit of your maximum physical possibilities and beyond, what any specialist in the field wants to see in the military they evaluate.

The Beep test is a new trend in assessing the level of physical training of the NATO military, with the US Army itself implementing this verification test for candidates wishing to enter the military system. This test can provide military specialists in physical education and sport with a practical means of determining the aerobic capacity of the military when space is limited; the route is unsuitable for outdoor running or when environmental conditions are unfavorable. The suggestions made in this written submission can help military organizations wishing to assess the aerobic capacity of their personnel (on periodic or initial tests – on entry into the system) by offering an alternative, namely the Beep test.

NOTES:

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3 <https://adrenallina.ro/ce-este-vo2-max-si-cum-variaza-de-la-un-sportiv-la-altul>, accessed on 24.03.2019.

4 <https://www.runnersworld.com/training/a26066029/increase-vo2-max>, accessed on 04.04.2020.

5 Fartlek means running at different paces.

6 <https://beepstacademy.com/beep-test-download>

7 After the Beep sonar signal, the level and speed to be traveled are communicated.

8 <https://www.strayfm.com/news/local-news/2454829/watch-harrogates-army-foundation-college-attempt-world-record>, accessed on 05.04.2020.

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