

Performance Training with or without Ball: A Comparison between Helgerud Method in Female Soccer

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Abstract: It is well known that intermittent running can bring great improvements in oxygen consumption, a similar physiological load deriving from intermittent run could be obtained by using ball during the football training, and in this way increase value of aerobic fitness. The present study aims to compare internal load (heart rate), between Helgerud method without the ball and the Helgerud 4vs4 method carried out with ball, to understand if it is possible to achieve improvements in aerobics fitness using exercise with ball in female soccer. The sample consisted of 11 female soccer players with an average age of 24.7 ± 4.22 , HRmax (heart rate max) 191.9 ± 4.87 and BMI (Body Mass Index) 21 ± 2.63 . Helgerud method was performed at 90-95% of HRmax lasting 4 minutes, repeated 4 times, with active intervals recovery at 70/75% of HRmax lasting 3 minutes, both with and without a ball. The evaluation was carried out through a test for aerobic endurance (YYRI1) in August (pre-test) and December (post-test). The 4vs4 continuous game (45×50 m) confirmed the same internal load as Helgerud without a ball. Moreover, the only use of ball in physical sessions during the first competitive period (September-December) has led to a significant improvement of the $VO_2\text{max}$.

Key words: Aerobic fitness, women soccer, $VO_2\text{max}$, heart rate, Helgerud, ball.

1. Introduction

At the end of the 1990s a Norwegian football team attracted the European spotlight: Rosenborg in the 1996-1997 season eliminated Sacchi's Milan in the group stage of Champions League. The scientific sports world began to take an interest in Norwegian researchers Jan Helgerud, Lars Christian Engen, Ulrik Wisløff and Jan Hoff. The hypothesis supported by the results of Wisløff et al. [1] in 1998, showed an indicative difference in the $VO_2\text{max}$ between the first team in standings (Rosenborg) and last team in standings (Strindheim) of the championship in first Norwegian division, confirming this hypothesis with the research from 2001 [2]. Research was mainly based on physiological adaptations due to specific intermittent running workload. Work-out: 4 runs series

of 4 minutes at 90/95% HRmax (heart rate max), interspersed with 3 minutes of running jogging at 70% HRmax, for a total of 28 minutes. This method called Helgerud (for the researcher) is an evolution of the physical working method previously adopted by the Norwegian Rosenborg team: The Rosenborg method (from which it takes its name) consisted of an intermittent running job of 4 series of 4 minutes at 90/95% of HRmax (maximum heart rate), followed by 4 minutes of run at 70% HRmax, for a total volume of 32 minutes training. Norwegian researchers demonstrated that the Helgerud method was one of the most effective for increasing $VO_2\text{max}$. The aims of this study were to transform the Helgerud method without ball, in a version with the ball. The study was performed with a women's soccer team (Santarcangelo Calcio, Emilia Romagna, Italy), militant in the Italian third series championship. The first step was to perform pre-tests in August, to evaluate the $VO_2\text{max}$.

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The main objective of this experimentation was to compare the internal work load, by monitoring heart rates between Helgerud without ball and Helgerud with the Ball; afterwards to evaluate if the integrated methodology used in the first competitive period (September-December) using only the ball, has significantly influenced the physiological parameters of aerobic power, strength and speed. The VO_2max , or maximum aerobic power is probably the most crucial parameter for endurance sports, it is equivalent to the maximum amount of oxygen expressed in mL/kg/min that can be used in the unit of time by an individual [3]. In a maximal exercise, oxygen stores and CO (cardiac output) seem to be the main factor for the release of oxygen and are considered determinants for VO_2max , even if, first of all, the improvements of VO_2max seem to be dependent with the initial level of fitness [4]. While untrained subjects are limited at the peripheral level, the trained people are mainly limited in central level, with the maximum SR (systolic range) identified as the main limiting factor of VO_2max [5, 6]. Zhou et al. showed that the increase in SR leads to an increase in VO_2max and consequently the intermittent training of 3-8 minutes with 90-95% workload of HRmax increases VO_2max by increasing the CO, thus improving the SV [7]. Various studies showed that VO_2max average value for international male soccer players ranges from 55-68 mL/kg/min, up to values above 70 mL/kg/min [8]. We consider that female players report a VO_2max 10-12% lower than men, due to anatomical and physiological characteristics: smaller left ventricle, blood mass and minor systolic discharge, reduced hemoglobin content resulting in a lower transport of oxygen to active muscles. We must also remember that the transport capacity of O_2 depends on the amount of Hb (hemoglobin) present in the blood: in 100 mL of blood in man there are 14-18 grams of Hb while in women there are 12-16 grams (1 gr of Hb = 1.34 of O_2). Furthermore, it has been demonstrated how a high capacity of this parameter has led to the improvement of the total distance of

game played, the number of sprint and a greater participation in the most decisive situations during matches [9].

2. Means and Method

Eleven female soccer players with an average age of 24.7 ± 4.22 , HRmax 191.9 ± 4.87 and BMI 21 ± 2.63 militant in Italian third series championship were tested in two different periods, August and December through some tests on the aerobic power, strength and speed. For the detection of the VO_2max and HRmax, the Yo-Yo Endurance Test 1 (YYET-1) was used. For monitoring players during YYET-1 an IPAD PRO 9.7" (iOS system, Apple, USA) was used, specifically the software Beep Test Team Trainer (Fast Software Pty Ltd, USA) was used, and an H7 Heart Rate Sensor Bluetooth bend (Polar, Finland) for the detection of HR. The Beep Test Team Trainer software has detected the VO_2max expressed in mL/kg/min by indirect method, based on the weight of the subject, distance travelled and test time. After performing the various pre-tests, during first week of preparation, players were divided into 2 groups: the first played a 4vs4 game without any game interruption in one 45×50 field in Helgerud mode with ball ($4 \times 4'$ at 90-95% HRmax, $4 \times 3'$ recovery at 70-75% HRmax), while the other group performed Helgerud intermittent without ball. In both groups and working methods, total duration of training was 28 minutes. Instrumentation problems allowed detection of only 6 players. In Helgerud 4vs4 group, the ball was always put back on the field by coaches at the end of each game action, in order to not lose the right intensity of exercise. Players were divided in two groups in order to obtain and record data from both Helgerud methods, at the end of first week both groups performed one aerobic session with ball and one without. After first week of training camp, Helgerud method with ball (4vs4) was performed one time a week during September, until the week before the first championship match. During championship period it was performed one time a week.

3. Data Analysis and Discussion

Fig. 1 shows how Helgerud method with the ball was, in this case, it is more effective from the point of view of the internal load compared to method without ball: 10 players among 11 spent more time on HRmax > 90% zone more with the ball method. These results are probably due to both physiological and psychological responses: in the physiological field we must consider the innumerable changes of direction and the continuous throw-in of the ball which determines the increase in heart rate and the maintenance of high intensity. On a psychological level, they are probably

due to a greater motivation towards working with the ball then without it.

The use of the ball during training sessions dedicated in development of Aerobic Power in the first competitive period has increased the VO₂max in all the athletes (Fig. 2). The average value of the team VO₂max equals 40.3 ± 6.6 mL/kg/min in August post-test and 56.1 ± 2.7 mL/kg/min in December post-test with an increase of $+15.8 \pm 5.7$ mL/kg/min between the two periods. Applying *T*-Student test, *p*-value was calculated, that was $p = 0.000$ ($p < 0.01$), which describes a relevant change.

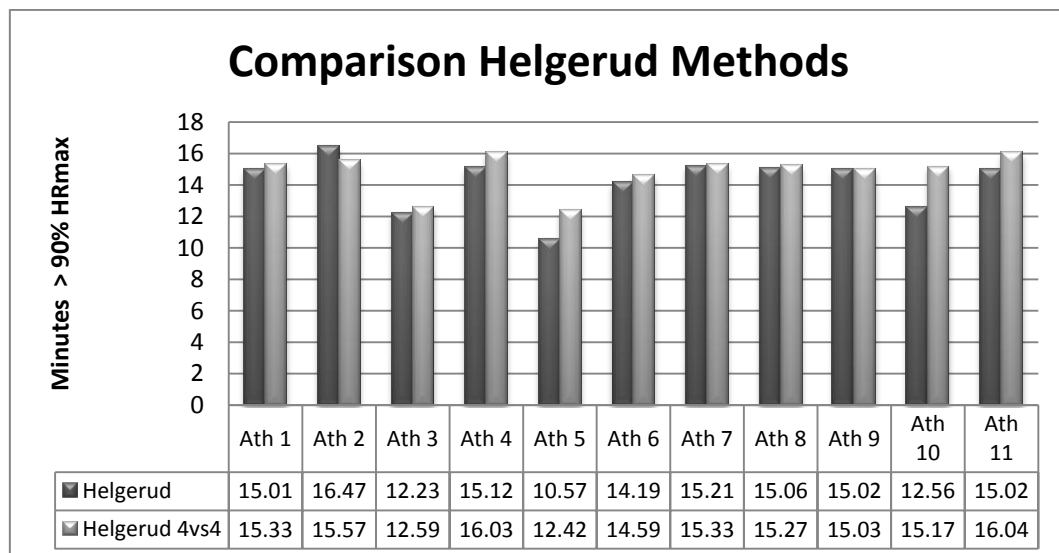


Fig. 1 Minutes spent in the high intensity zone (> 90% HRmax) by athletes in Helgerud without ball and Helgerud 4vs4 with ball.

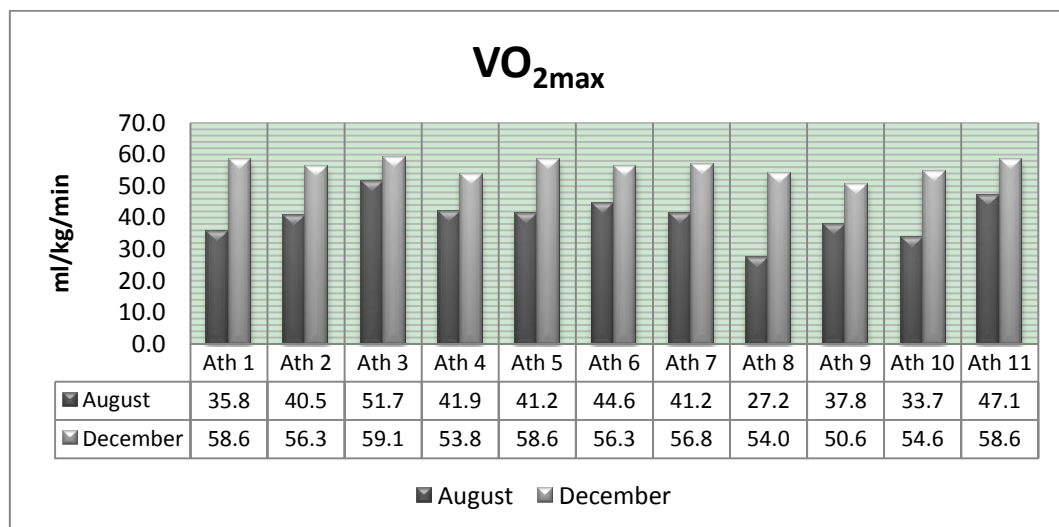


Fig. 2 VO₂max (mL/kg/min) detected by the athletes in pre-test during August and post-test in December.

Table 1 Values of VO₂max detected from YYET-1 pre-test and post-test.

Athletes	VO ₂ max August	VO ₂ max December	ΔVO ₂ max
	mL/kg/min	mL/kg/min	mL/kg/min
Ath. 1	35.8	58.6	+22.7
Ath. 2	40.5	56.3	+15.7
Ath. 3	51.7	59.1	+7.4
Ath. 4	41.9	53.8	+11.9
Ath. 5	41.2	58.6	+17.4
Ath. 6	44.6	56.3	+11.7
Ath. 7	41.2	56.8	+15.6
Ath. 8	27.2	54	+26.8
Ath. 9	37.8	50.6	+12.8
Ath. 10	33.7	54.6	+20.9
Ath. 11	47.1	58.6	+11.4
Team Average	40.3 ± 6.6	56.1 ± 2.7	+15.8 ± 5.7

VO₂max = Aerobic fitness (mL/Kg/min); ΔVO₂max = Delta from August pre-test and December post-test.

Through the match analysis, it was found that on average, a player has the ball for about 3 minutes, travels about 10-12 km [10] at an average intensity close to the anaerobic threshold at 80-90% of the HRmax or 70-80% of the maximum oxygen consumption (VO₂max), performing 2.4 km at high intensity (> 15 km/h) [11, 12]. Players make about 750 changes of direction, one every 3-4 seconds, which is the most frequent mode of movement in football. Already previously studies, have demonstrated the efficiency of using the ball for the development of the aerobic power. We must not forget that soccer is a situational acyclical sport, so football runs and training method cannot be cyclical, because the demands of the game require players to adjust the interchange between short periods of high intensity run with longer recovery periods with an alternating metabolic commitment [13]. The data obtained from the heart rate measured in the two Helgerud methods confirm the possibility of achieving and maintaining high intensity values and therefore benefiting from the development of the physiological parameters, not only with running without ball [14]. In addition (Table 1), we verified that only the use of ball during training sessions can increase VO₂max parameter (team average +15.8 ± 5.7 mL/kg/min). Players averaged, 14.2 ± 1.7 minutes in the area of maximum intensity (heart rate > 90% of

HRmax) during the execution of Helgerud without ball and 14.9 ± 1.2 minutes in area of maximum intensity in Helgerud 4vs4 (Fig 1). The exercise carried out with the ball certainly has a higher cognitive load than classic aerobic exercise, in fact, Spanish and British researchers have confirmed that the exercises that integrate the high intensity actions with the ball are more advantageous and contribute to improving the potential of the player developing functional qualities to the game. Previously Bangsbo et al. had already shown that playing a 4vs4 in a half football field required a higher work intensity, compared to an SSG (small side game), at the same time Platt et al. showed how the SSG, with the variation of the number of touches, determined elevated increases of the heart rate, useful for the improvement of both physical and technical parameters. Helgerud et al. demonstrated, through Hoff Test using the ball, the possibility to increase VO₂max level.

4. Conclusions

The present study wanted to confirm the previous works used by Norwegian researchers, applying however, the Helgerud method directly with the ball through a 4vs4 in a 45 × 50 field, with the ball. Data analysis shows that all the players spent 14.9 ± 1.2 minutes at a frequency greater than 90% of the HRmax

over 16 minutes of high intensity zone (> 90% HRmax) in the Helgerud 4vs4 method. Players without ball spent 14.2 ± 1.7 minutes over high intensity zone. Those data confirm the effectiveness of the Norwegian researchers' method for developing aerobic endurance, since the VO_2max team average is increased in average 15.8 mL/kg/min, with a $p = 0.000$ ($p < 0.01$). Future applications could be possible to enlarge the study group, and to test two teams for one entire year using the two different protocols. In this way it will be possible to define differences about the one or the other aerobic training method. In conclusion the integrated training could improve the aerobic characteristics of the athletes and replace classic aerobic training method as long as it reaches the internal load required for the desired physiological objectives, in respect and prevention of athletes. The final idea is trying to train using always exercises with ball even to develop fitness parameters.

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