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Investigation of changes in blood lactate and some performance characteristics of adolescent male handball players during competition

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Abstract

High lactic acid levels in high-configuration exercises can lead to a decrease in the performance of athletes. The aim of this study is to examine the changes in the characteristics of lactic acid (LA), dominant hand grip strength (DHGS), 20 m sprint and vertical jump (VJ) during the a match. In the study, blood lactate, dominant hand power, vertical power and 20 m sprint values were determined from the subjects, which were taken three times in total, at the end of the warm-up, before the start of the match, at the end of the first half and end of the match. 22 male handball players aged 12-14, playing in the U16 Handball League in 2022-2023, voluntarily participated in this research. The mean age of the subjects was 14,09±0,86 years, and the mean age of sports was 4,04±0,84 years. One-Way ANOVA was performed to analyze the difference. In our study, when the analysis results of lactic acid measurement and DHGS measurements are examined, it is seen that there is a statistically significant difference between pre-competition measurement (PrCM) and half-time measurement (HTM), PrCM and post-competition measurement (PoCM), HTM and PrCM ($P < 0.05$). In addition, when the VJ measurement analysis results are examined, there is a statistically significant difference between PrCM and PoCM, HTM and PoCM results, and between PrCM and HTM, PrCM and PoCM results in the 20 m sprint test ($P<0.05$). There is an increase in the level of lactic acid in adolescent handball players during the competition, which negatively affects the performance of the athletes.

Keywords*:* Blood lactac, handball, hand grip strength, speed, vertical jump

Adölesan erkek hentbolcularda müsabaka süresince kan laktat ve bazı performans özelliklerindeki değişimlerin incelenmesi

Öz

Yüksek yoğunluklu egzersizlerdeki yüksek laktik asit seviyeleri, sporcuların performansının düşmesine neden olabilir. Bu çalışmanın amacı, bir maç sırasında laktik asit (LA), baskın el kavrama kuvveti (BEKK), 20 m sürat koşusu ve dikey sıçrama (DS) özelliklerinin değişiminin incelenmesidir. Çalışmada ölçümler deneklerden, maç başlamadan önce yapılan ısınma sonunda, ilk yarı sonunda ve maç bitiminde olmak üzere toplam üç kez alınan kan laktatı, baskın el kavrama kuvveti, dikey sıçrama ve 20 m sprint değerleri tespit edilerek gerçekleştirildi. Bu araştırmaya 2022-2023 yılı Türkiye U 16 Hentbol Ligi'nde oynayan 12-14 yaş grubu 22 erkek hentbolcu gönüllü olarak katılmıştır. Katılımcıların yaş ortalamalarının 14,09±0,86 yıl, antrenman yaşlarının ortalaması ise 4,04±0,84 yıldır. Farkı analiz etmek için Tek Yönlü ANOVA yapıldı. Çalışmada LA ölçümü ile BEKK ölçümleri analiz sonuçlarına bakıldığında müsabaka öncesi ölçüm (MÖ) ve devre arası ölçüm (DA), müsabaka öncesi ölçüm ve müsabaka sonrası ölçüm (MS), DA ve MS ölçüm sonuçları arasında istatistiksel olarak anlamlı farklılık olduğu görülmektedir ($P<0,05$). Ayrıca DS ölçümü analiz sonuçlarına bakıldığında MÖ ve MS, DA ve MS sonuçları arasında, 20 m sürat testinde ise MÖ ve DA, MÖ ve MS sonuçları arasında istatistiksel olarak anlamlı farklılık olduğu tespit edilmiştir ($P<0,05$). Sonuç olarak; adölesan hentbolcularda müsabaka süresince laktik asit düzeyinde artış olduğu bunun da sporcuların performanslarını olumsuz etkilediği tespit edilmiştir.

Anahtar Kelimeler: *El kavrama kuvveti, dikey sıçrama, kan laktatı, hentbol, hız*

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INTRODUCTION

The aim in sports is for the athletes to show high performance and achieve the desired success (Platonov, 2019; Nematovich et al., 2020). The physical, physiological, psychological, technical and tactical characteristics of the athlete are the most important determinants of performance in sports (Abraldes et al, 2016; Günay et al, 2017). It is possible to increase these features to the desired level only with special trainings to be applied (Roberts & Treasure, 2012; Abduyeva, 2022). In the science of movement and training, methods, methods and practices are important elements that should be known to increase the performance development of athletes (Adolph et al., 2003). It is known that athletes competing in different sports have different performance characteristics (Stojanovic et al., 2016; Morteza-Tayebi et al., 2017). Handball is a sports branch played all over the world, attracting many spectators due to its high level of struggle, attracting attention and being the subject of much research (Kotzamanidis, 1989; Loftin et al., 1996; Rannou et al., 2001; Saavedra et al., 2018; Abduyeva, 2022). Since endurance, maximum muscle strength, power (explosive power) and high jumping ability, speed are important for technical and tactical skills, especially during passing, jumping and shooting in handball, the development of these performance skills will provide a separate advantage to the handball players (Cardinale, 2017). When we look at the literature, we can see the studies of Coutts et al. (2003) with professional rugyb players, Abdelkrim et al. (2010) with basketball players, Dawson et al. (2005) with football players, Howell et al. (1993) with sedentary students on the change of lactic acid and performance characteristics during exercise. However, no study has been found on adolescent handball players. The aim of this study is to examine the changes in the characteristics of lactic acid, dominant hand grip strength, 20 m speed and vertical jump during the competition.

Thus, it will be possible to have information about the endurance characteristics, 20 m speed, dominant hand grip strength and vertical jump characteristics of the adolescent male handball players during the competition. As a result of this study, scientific advice will be given to trainers and athletes in the handball branch in training plans to increase performance, and it will also contribute to the studies to be done in this field.

Thus, by gaining knowledge about the endurance characteristics, 20 m speed, dominant hand grip strength and vertical jump characteristics of the adolescent male handball players during the competition, scientific advice will be given to the coaches and athletes in the

training planning in order to increase the performance, and also contribute to the studies to be carried out in this field from now on.

METHOD

Participants

22 male handball players aged 12-14, who have been playing handball regularly for at least 3 years (1 hour 3 days a week) in the Turkish U16 Handball League team of Mardin Yeşilli District Handball Club between 2022 and 2023, voluntarily participated in this research.

Design and procedures

This research; It was designed according to the experimental model, one of the quantitative research methods. In the experimental model, lactic acid test, dominant hand grip strength test, 20 m sprint test, vertical jump test were applied to the participants. The study measurements were carried out in a training session in the Turkish THF (Turkish Handball Federation) League of the 2022-2023 season.

Data collection

In the study, blood lactate, dominant hand power, vertical power and 20 m sprint values were determined from the subjects, which were taken three times in total, at the end of the warm-up, before the start of the match, at the end of the first half and end of the match. All tests were applied by the same researchers and at the same time (in pre-competition; in half-time; in post-competition) in sports facilities where the athletes participated in team training. Before the tests, the measurements to be made were explained theoretically to the athletes and the measurements were made after the athlete was ready (warm-up) by repeating the trial before the measurement. Blood samples were drawn 3 times from each volunteer – at rest, within 1 min after the end of warm up, and immediately after the end of each half (within 1 min) of the matches. Each athlete was given a recovery time of 5 minutes after the other measurement. Lactic acid measurement was made by taking a very small amount of blood sample (0.5-7 μL) from the earlobes of the athletes with the help of an Accu Chek Softlix Lancet needle using the Lactate SCOUT device (Walsh et al., 2004). Dominant hand grip strength was measured with a digital hand dynamometer (Tamer, 2000) and 20 m speed test measurement was performed with the help of photocell. The vertical jump test measurement was carried out by determining the distance between the marked point before the jump and the next point (Günay et al., 2019).

Statistical analysis

SPSS 22.0 program was used for statistical operations. Shapiro-Wilk test was used to test for normality. One-Way ANOVA and LSD tests were performed to analyze the difference between Repeated Measurements. Values were presented as mean, standard deviation, standard error 95% confidence interval and were analyzed at $p<0.05$ significance level.

FINDINGS

Table 1. Demographic characteristics of the participants

Variables	N	X	SS	Min	Maks
Age (years)	22	14,09	0,86	13	15
TA (years)	22	4,04	0,84	3	5
H (cm)	22	135,55	6,22	125	146
BW (kg)	22	38,96	5,45	30,50	46,40

TA: Training Age, H**:** Height**, BW:** Body Weight

Looking at Table 1 above, it is seen that the average age of the participants is 14.09 years, the average age of training is 4.04 years, and their height is 135.55 cm and their body weight is 38.96 kg.

Table 2. Statistical analyzes of participants between measurements

Variables	PrCM	HTM	PoCM	p	DBM
LA (mMol/L)	1,59±0,26	2,08±0,31	1,88±0,27	**0,000***	PrCM - HTM, PrCM-PoCM, HTM - PoCM
DHGF (kg)	44,25±73,99	43,02±3,28	41,78±3,06	**0,000***	PrCM - HTM, PrCM- PoCM, HTM - PoCM
VJ (cm)	42,50±4,42	42,31±3,99	40,50±4,18	**0,000***	PrCM- PoCM, HTM - PoCM
20 m sprint (sn)	3,78±0,43	4,08±0,33	4,10±0,44	**0,000***	PrCM - HTM, PrCM - PoCM

***p<0,05; PrCM:** Pre-Competition Measurement; **HTM:** Half-Time Measurement; **PoCM:** Post-Competition Measurement; **ACA**: All Competition Average; **LA:** Lactic Acid; **DHGF:** Dominant Hand Grip Force **VJ:** Vertical Jump; **DBM:** Difference Between Measurements

Looking at Table 2, when the analysis results of lactic acid measurement and dominant hand grip strength measurements are examined, it is seen that there is a statistically significant difference between pre-competition measurement and half-time measurement, pre-competition measurement and post-competition measurement, half-time measurement and post-competition measurement results ($p<0.05$). In addition, when the vertical jump measurement analysis results are examined, there is a statistically significant difference between pre-competition measurement and post-competition measurement, half-time

measurement and post-competition measurement results, and between pre-competition measurement and half-time measurement, pre-competition measurement and post-competition measurement results in the 20 m sprint test. It was determined that there was a difference ($p<0.05$).

DISCUSSION AND CONCLUSION

This study was conducted to examine the changes in the lactate level, dominant hand grip strength, vertical jump and 20 m sprint test characteristics of adolescent male handball players during a match. The average age of the participants was 14.09 years, the average training age was 4.04 years, and the averages of height and body weight were determined as 135.55 cm and 38.96 kg, respectively.

The level of lactic acid in the blood of trained individuals at rest is 0.5–2.2 mmol/L (Gau, 1984; Hermansen & Stensvold, 1972). After maximal loads, the oxygen deficit continues to increase and the amount of lactic acid in the blood increases with the intensity of exercise, as anaerobic metabolism is dominant (Fox & Foss, 1988; Astrand, 1986; Steiininger, 1980). As it is known, high lactic acid level and muscle damage in high-intensity exercises can lead to a decrease in the performance of activities that require fast movement such as endurance, strength and speed as a result of pain and loss of strength in the muscles (Faulkner, Brooks & Opiteck, 1993; Michalsik et al., 2021). In our study, we can say that lactate levels of handball players increase with increasing violence during a match, and when we look at the results, we can say that the lactic acid level between the half time is higher than the results before and after the competition. Looking at the literature, Coutts et al. (2003) found lactate concentrations to be 7.2 mmol\L before the match, 8.4 mmol\L during the match, and 5.9 mmol\L after the match in their research on semi-professional rugby league teams. Abdelkrim et al. (2010) reported the lactate levels of Tunisian national league basketball players as 6.2 and 5.3 mmol\L in the first half and after the competition, respectively. The lactic acid values obtained in our study are slightly lower than the literature, and the change in the competition process is similar to the literature. The reason for the low lactic acid values is thought to be due to the frequency, intensity, duration and scope of the training they do because the athletes in our study are adolescents and the athletes in the other studies are at the elite level and adult age group. On the other hand, literature information on the fact that lactic acid values at the end of the match are lower than at the end of the first half support the results of our study. This situation can be explained by the effect of the rest period in the half-time on the

recovery, the score advantage of the athletes in the second half or the decrease in the tempo due to fatigue caused by the decrease in energy stores.

When we look at the analysis results of dominant hand grip strength measurements in our study, it is seen that there is a statistically significant difference between pre-competition measurement and half-time measurement, pre-competition measurement and post-competition measurement results in favor of the pre-competition result ($p<0.05$). In high-intensity exercises, tension, muscle pain, swelling, decrease in joint range of motion, and loss of strength after exercise-induced muscle damage can lead to loss of strength (Dawson et al., 2005). Howell et al. (1992) stated in their study that as a result of eccentric exercise performed with 90% of maximal strength, the decrease in strength on the biceps muscle was 40%. Considering the activities of the athletes in the handball branch, such as passing and shooting during the game, it is known that high-intensity contractions in the upper extremity muscles are applied during the competition. This is thought to cause a decrease in the hand grip strength of the athletes in our study, since lactic acid accumulation, muscle damage and the discharge of energy resources in handball players cause fatigue, especially in the upper extremity muscles. In our study, it was determined that there was a statistically significant difference in favor of the pre-competition results between the pre-competition measurement and half-time measurement, pre-competition measurement and post-competition measurement results in the 20 m sprint test ($p<0.05$). Twist and Eston (2005) reported in their study that a statistically significant decrease of approximately 3% occurred in the 10 m speed feature after jumping using the arms 100 times. Movement activities and results in this study support our study. According to this information, it is thought that the amount of lactic acid that increases during the competition negatively affects the speed characteristic of handball players. In addition, when we look at the results of the vertical jump measurement analysis in our study, it has been determined that there is a statistically significant difference in favor of the pre-competition results when the pre-competition measurement, the half-time measurement and the post-competition measurement results are examined ($p<0.05$). Hornery et al. (2007) reported that the increase in the amount of CK, which increases depending on the amount of lactic acid, may cause fatigue and decrease in power production. In addition, studies in the literature report that eccentric muscle contraction may cause loss of strength. As a result of eccentric contraction It is thought that early loss of function may result from mechanical damage as well as disruptions in the excitation-contraction link. Irregularities in depolarization and calcium release in the cell membrane can affect the speed and amount of

contraction (Skurvydas et al., 2006; Tiidus, 2008). With this information that supports our study, it is thought that there is a decrease in the vertical jump feature in handball players due to the increase in the amount of lactic acid during the match and the nervous muscle deterioration caused by fatigue.

There is an increase in the level of lactic acid in adolescent handball players during the competition, which negatively affects the performance of the athletes,

Recommendations

It is thought that it will be beneficial for the trainers to consider the physiological characteristics of their athletes while evaluating their performance, and it is thought that the athletes will be more successful by exhibiting high performance with the endurance, strength and speed exercises specific to the handball branch movement activities at the appropriate intensity, duration and frequency to be made in the light of scientific findings and studies.

GENİŞLETİLMİŞ ÖZET

GİRİŞ

Sporda amaç sporcuların yüksek performans sergileyip istenilen başarıya ulaşmalarıdır Platonov, 2019; Nematovich ve ark., 2020). Sporda sporcunun fiziksel, fizyolojik, psikolojik, teknik ve taktik özellikleri performansın en önemli belirleyicileridir (Abraldes ve ark., 2016). Bu özelliklerin istenilen seviyeye çıkarılabilmesi de ancak uygulanacak özel antrenmanlar ile mümkündür (Roberts ve Treasure, 2012; Abduyeva, 2022). Hentbolda dayanıklılık, maksimum kas kuvveti, güç (patlama gücü) ve yüksek sıçrama becerisi, sürat özellikle pas atma, atlama ve atış sırasında teknik ve taktik beceriler için önemli olduğundan bu performans becerilerinin geliştirilmesi sporculara ayrı bir avantaj sağlayacaktır (Cardinale, 2017). Yapılan bu çalışmada amaç adölesan erkek hentbocuların müsabaka süresince laktik asit, baskın el kavrama kuvveti, 20 m sürat ve dikey sıçrama özelliklerindeki değişimleri incelemektir.

YÖNTEM

Bu araştırmaya 2022-2023 yılı Türkiye U 16 Hentbol Ligi takımı Mardin Yeşilli İlçesi Hentbol Kulübü'nde oynayan ve en az 3 yıldır düzenli olarak haftada 3 gün yaklaşık 1 saatlik hentbol antrenmanlarına katılan 12-14 yaş grubu 22 erkek hentbolcu gönüllü olarak katılmıştır. Her gönüllüden istirahatte, ısınmanın bitiminden sonraki 1 dakika içinde ve maçların her yarısının bitiminden (1 dakika içinde) hemen sonra olmak üzere 3 kez kan örnekleri alındı. Her sporcuya diğer ölçümden sonra 5 dakikalık bir toparlanma süresi verildi. Laktik asit ölçümü, Lactate SCOUT cihazı ile kullanılarak sporcuların kulak memelerinden Accu Chek Softlix Lancet iğne yardımıyla çok azmiktarda kan örneği (0,5-7 μL) alınarak yapıldı (Walsh ve ark., 2004). Baskın el kavrama kuvveti dijital el dinamometresi aleti ile (Tamer, 2000) 20 m sürat testi ölçümü, fotosel yardımı ile

gerçekleştirildi. Dikey sıçrama testi ölçümü ise, sıçrayıştan önceki işaretlenen nokta ile sonraki nokta arasındaki mesafe tespit edilerek gerçekleştirildi (Günay ve ark., 2019). Uygulamalar arasındaki laktat farkının analizi için Repeated Measures One Way ANOVA ve LSD testleri yapıldı.

BULGULAR

Katılımcıların yaş ortalamalarının 14,09±0,86 yıl, antrenman yaşlarının ortalaması ise 4,04±0,84 yıldır. Farkı analiz etmek için Tek Yönlü ANOVA yapıldı. Çalışmada LA ölçümü ile BEKK ölçümleri analiz sonuçlarına bakıldığında müsabaka öncesi ölçüm (MÖ) ve devre arası ölçüm (DA), müsabaka öncesi ölçüm ve müsabaka sonrası ölçüm (MS), DA ve MS ölçüm sonuçları arasında istatistiksel olarak anlamlı farklılık olduğu görülmektedir ($p<0,05$). Ayrıca DS ölçümü analiz sonuçlarına bakıldığında MÖ ve MS, DA ve MS sonuçları arasında, 20 m sürat testinde ise MÖ ve DA, MÖ ve MS sonuçları arasında istatistiksel olarak anlamlı farklılık olduğu tespit edilmiştir ($p<0,05$).

TARTIŞMA VE SONUÇ

Antrenmanlı bireylerin dinlenme halinde kandaki laktik asit düzeyi 0,5–2,2 mmol/L'dir (Gau, 1984; Hermansen & Stensvold, 1972). Maksimal yüklenmelerden sonra oksijen açığı artmaya devam eder ve anaerobik metabolizma baskın olduğundan, kandaki laktik asit miktarı egzersizin şiddeti ile birlikte yükselir (Fox & Foss, 1988; Astrand, 1986; Steiininger, 1980). Bilindiği gibi yüksek yoğunluktaki egzersizlerde yüksek laktik asit seviyesi ve kas hasarı sonucu kaslarda ağrı ve güç kaybı sonucu dayanıklılık, kuvvet ve sürat gibi hızlı hareket etmeyi gerektiren aktivitelerin performansında düşüşe yol açabilir (Faulkner ve ark., 1993; Michalsik ve ark., 2021). Çalışmamızda hentbol oyuncularının bir müsabaka süresince artan şiddet ile birlikte laktat seviyelerinin de arttığını ayrıca sonuçlara bakıldığında devre arasındaki laktik asit seviyesinin müsabaka öncesi ve sonrası sonuçlarına göre daha yüksek çıktığını söyleyebiliriz. Abdelkrim ve arkadaşları (2010) Tunus ulusal lig basketbol oyuncularının laktat seviyelerini ilk yarı ve müsabaka sonrasında sırasıyla 6,2 ve 5,3 mmol\L olarak bildirmektedir. Çalışmamızda elde edilen laktik asit değerleri literatüre göre bir miktar düşük, müsabaka sürecindeki değişim ise literatür ile benzerlik içerisindedir. Laktik asit değerlerindeki düşüklüğün sebebi çalışmamızdaki sporcuların adölesan diğer çalışmalardaki sporcuların ise elit düzeyde ve yetişkin yaş grubunda olmalarından dolayı yaptıkları antrenman sıklık, şiddet, süre ve kapsamından kaynaklandığı düşünülmektedir.

Çalışmamızda baskın el kavrama kuvveti ölçümleri analiz sonuçlarına bakıldığında müsabaka öncesi ölçüm ve devre arası ölçüm, müsabaka öncesi ölçüm ve müsabaka sonrası ölçüm sonuçları arasında müsabaka öncesi sonucu lehine istatistiksel olarak anlamlı farklılık olduğu görülmektedir ($P<0,05$). Yüksek yoğunluktaki egzersizlerde egzersize bağlı kas hasarı sonrası oluşan gerginlik, kas ağrısı, şişme, eklem hareket açıklığında azalma, kuvvet kaybına yol açabilmektedir (Dawson ve ark., 2005). Çalışmamızda 20 m sürat testinde ise müsabaka öncesi ölçüm ve devre arası ölçüm, müsabaka öncesi ölçüm ve müsabaka sonrası ölçüm sonuçları arasında müsabaka öncesi sonuçları lehine

istatistiksel olarak anlamlı farklılık olduğu tespit edilmiştir (p<0,05). Twist ve Eston (2005) yaptıkları çalışmalarında 100 kez kollar kullanarak yapılan sıçrama sonrasında 10 m sürat özelliğinde yaklaşık %3'lük istatistiksel olarak anlamlı bir azalmanın meydana geldiğini aktarmaktadırlar. Bu bilgilere göre müsabaka süresince artan laktik asit miktarı hentbolcularda sürat özelliğini negatif etkilediği düşünülmektedir. Ayrıca çalışmamızda dikey sıçrama ölçümü analiz sonuçlarına bakıldığında müsabaka öncesi ölçümü ile devre arası ölçüm ve müsabaka sonrası ölçüm sonuçlarına bakıldığında yine müsabaka öncesi sonuçları lehine istatistiksel olarak anlamlı farklılık olduğu tespit edilmiştir (p<0,05). Hornery ve arkadaşları (2007) laktik asit miktarına bağlı olarak artan CK miktarının artmasının yorgunluğa ve güç üretiminde azalışa sebep olabileceğini bildirmişlerdir.

Sonuç olarak; adölesan hentbolcularda müsabaka süresince laktik asit düzeyinde artış olduğu bunun da sporcuların performanslarını olumsuz etkilediği, antrenörler sporcularının performanslarını değerlendirirken fizyolojik özelliklerini de göz önünde bulundurmaları onlara yarar sağlayacağı ayrıca bilimsel bulgu ve çalışmalar ışığında yapılacak uygun şiddet, süre ve sıklıkta hentbol branşı hareket aktivitelerine özgü dayanıklılık, güç ve sürat çalışmaları ile sporcuların yüksek performans sergileyip daha başarılı olabilecekleri düşünülmektedir.

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Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Mustafa TÜRKMEN
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Mustafa TÜRKMEN
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Mustafa TÜRKMEN
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Mustafa TÜRKMEN

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