

## Updated variables as indicators of muscle fatigue for soccer youngsters

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**Abstract:** Aim of the study to determine the updated variables as indicators of muscle fatigue for soccer youngsters, the researcher used the descriptive method due to the suitability of the nature of the study, (20) young soccer players were chosen from port Fouad club under (17) years to participate in the study, the study lasted for (1) day, the participants were subjected to a training unit with maximum intensity, (5) ml venous blood were withdrawn before and after the training unit for evaluation of... creatine kinase enzyme, sodium  $\text{Na}^+$ , potassium  $\text{K}^+$ , calcium  $\text{Ca}^+$ , cholinesterase enzyme, hematocrit value and prolactin hormone, beside... lactate and  $\text{VO}_2$  max, the results indicated an elevated concentration level of... cholinesterase, hematocrit, prolactin, creatine kinase and lactate, as for the minerals... sodium, potassium and calcium, there were a lower concentration at the end of the training unit, in conclusion, some updated variables as... cholinesterase, hematocrit, prolactin, sodium, potassium and calcium levels can be used as indicators of muscle fatigue together with the classical variables as... lactate,  $\text{VO}_2$  max, creatine kinase and pulse rate.

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**Key words:** Update variables – Muscle fatigue-Soccer youngsters.

### 1. Introduction and research problem

Fatigue can be defined as a loss of ability to continue given level of physical workout or performance, glycogen is essential to performance for both anaerobic and aerobic activities, muscle being strenuously exercised will rely on glycogen to power these strength generating muscle contractions, in endurance exercise while the primary fuel is fatty acids, glycogen is also utilized, so glycogen depletion is just one factor that contributes to the onset of fatigue, other factors can also be mentioned... ATP and CP depletion, lactic acid accumulation, calcium ion buildup in muscle, oxygen depletion and blood PH decrease. (19:25)

Reilley et al. (2008) reported that one of the consequences of sustaining exercise for a long time course of a match play is that the capability of muscle to generate force decline. (28: 357)

Carling et al. (2005) added that other causes may lead to fatigue as the thermoregulation strain which may be encountered resulting in a fall in physical performance or they may be a reduced central drive from the nervous system. (10: 22)

While, Guyton and Hall (2006) stated that the depletion of acetyl choline hormone may be a possible cause of muscle fatigue. (18: 88)

Bangsbo (1994), Bangsbo and Mohr (2005) stated that it must be other explanations causing muscle fatigue related to potassium accumulation in the muscles, this might be proved by measuring

potassium after a strenuous exercise protocol. (4: 619), (5:87)

Bangsbo et al. (2006) added that physical and metabolic demands of training and match play as another cause, the distance covered per game was found to vary with positional role, the highest distances being covered by midfield players, while those in central defense covered the least distance among players, also dehydration might play an important role in muscle fatigue. (6: 665)

Cordova et al. (2004) blamed some chemical substances in the blood that might be encountered in muscle fatigue and muscle damage, such as prostaglandins, heat shock proteins and chemokines together with creatine kinase. (13: 1013)

Heshmat et al. (2013) proposed other causes may be blamed in inducing muscle fatigue such as PH decrease or increase prolactin together with increased free fatty acids, also the changes in phosphors, natrium, potassium and calcium, also adinosinediphosphate which might lead to depress muscle contraction. (20: 339)

So, the aim of this study was to reports the updated variables as indicators of muscle fatigue for soccer youngsters.

It is hypothesized that the exhaustive exercise till muscle fatigue might cause significant changes in the different variables indicating fatigue.

## 2. Research procedures

**Research method:** The researcher used the descriptive method due to the suitability of the nature of the study.

**Research sample:** (24) young soccer players were chosen from Port Fouad club under (17) years to participate in the study, (20) players for the main study and (4) players for the pilot study.

**Table (1): Research sample**

The club	Main study	Pilot study
Port Fouad under (17) years	20 players	4 players

### Sample homogeneity:

**Table (2): Arithmetic mean, median, standard deviation, skewness in variables of age, height, weight, training experience and BMI. N=20**

Variables	U of M	A.Mean	Median	S.D.	Skewness
Age	years	17.5	17.4	0.23	1.3
Height	cm	173.2	173.5	3.7	- 0.24
Weight	kg	68.2	68	3.56	0.17
Training experience	years	7.2	7	0.69	0.86
BMI	kg/m <sup>2</sup>	22.8	22.7	0.51	0.59

**Table (3): Significance of differences between pre & post measurements in variables of the study. N=20**

Variables	U of M	N. Ranks		S. Ranks		( T ) value		Sig
		-	+	-	+	Table	Calcu.	
Lactate	mmol/l	0	20	0	210	52	0	S
VO <sub>2</sub> max	ml/kg/mi	20	0	210	0	52	0	S
Creatine kinase	iu/l	0	20	0	210	52	0	S
Na <sup>+</sup>	meq/l	20	0	210	0	52	0	S
K <sup>+</sup>	meq/l	20	0	210	0	52	0	S
Ca <sup>+</sup>	meq/l	20	0	210	0	52	0	S
Cholinesterase	pg/ml	0	20	0	210	52	0	S
Hematocrit	%	4	16	24	186	52	24	S
Prolactin	mg/ml	0	20	0	210	52	0	S

Table (2) reported that skewness were between ( $\pm 3$ ) indicating homogeneity of the sample.

### Data collection tools:

- **Height:** by using... Restameter.
- **Weight:** by using... Medical scale.
- **Body Mass Index:** by using formula... BMI = weight / height<sup>2</sup>.
- **Lactic acid:** by using... Accusport.
- **VO<sub>2</sub> max:** by using... The queens college step test.
- **Physiological variables:** (5) ml venous blood were withdrawn before and after the training unit with maximal intensity for evaluate concentration level of...
  - Creatine kinase enzyme, cholinesterase enzyme and prolactin hormone... by using... Elisa...
  - Hematocrit value: by using... Centrifuge.
  - Sodium Na<sup>+</sup>, Potassium K<sup>+</sup>, Calcium Ca<sup>+</sup>: by using... atomic absorption.
  - All blood samples were with drawn by a specialist, laboratory measurements were conducted at... Allawah laboratory in Port Said.

### Pilot study:

(4) young soccer players were the participants of the pilot study, they were from the same community out of the main sample, for a period of (2) days before the study, the reason is to...

- Investigate the soundness of the equipment and tools.
- To know the problems that might face the study.
- Determine the best ways to perform measurements and record data.

### Main study:

- The training unit with maximal intensity was performed on all the participants (20) players on 10/10/2014.
- (125) minutes training unit time was divided to... warming up (15) minutes- main part (105) minutes - cooling down (5) minutes.
- Measurements of lactate and VO<sub>2</sub> max.
- (5) ml venous blood were withdrawn before and after the training unit for evaluate concentration level of... creatine kinase enzyme, sodium Na<sup>+</sup>, potassium

K<sup>+</sup>, calcium Ca<sup>+</sup>, cholinesterase enzyme, hematocrit value and prolactin hormone.

**Statistical data analysis:** Using (SPSS) including.

- Arithmetic mean.
- Median.
- Standard deviation.
- Skewness.
- Wilcoxon signed rank test.

- Rates of changes formula.

### 3. Results

Table (3) reported significant changes in lactate, VO<sub>2</sub> max, creatine kinase, significant decrease of Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>+</sup>, a higher concentration of cholinesterase and prolactin together with hematocrit value after the training unit.

**Table (4): Rates of change in variables of the study. N=20**

Variables	U of M	Pre- measurement	Post- measurement	The difference between means	Change Rates %
		M	M		
Lactate	mmol/l	1.28	4.26	2.98	11.37
VO <sub>2</sub> max	ml/kg/mi	51.8	46.3	5.5	10.62
Creatine kinase	iu/l	26.2	48.2	22	83.96
Na <sup>+</sup>	meq/l	150	140.1	9.9	6.6
K <sup>+</sup>	meq/l	4.60	3.86	0.74	16
Ca <sup>+</sup>	meq/l	4.79	4.11	0.68	14.19
Cholinesterase	pg/ml	69.5	110.6	41.1	59.13
Hematocrit	%	42.6	44.9	2.3	5.39
Prolactin	mg/ml	28.2	51	22.8	80.85

Table (4) reported rates of change between pre & post measurements in lactate, VO<sub>2</sub> max, creatine kinase, Na<sup>+</sup>, K<sup>+</sup>, Ca<sup>+</sup>, cholinesterase, hematocrit and prolactin.

### 4. Discussion

Cordova et al. (2004), Macintyre et al. (1995) stated that strenuous physical exercise commonly results in muscle fatigue and injury, especially when that exercise is intense, prolonged and includes an important eccentric component. (13: 1010), (26:24)

Abalnave and Thompson (1993) reported that Individuals may perceive the muscle damage approximately (24) hours after exercises. (2:1545)

Armstrong (1990) added the event may be related to high specific tensions produced by the muscle, which results in sharing of the myofibrils and disturbances in the metabolic environment example a reduction of PH in the muscle or increased temperature in the activated muscles, it is proposed that injury of the muscle is followed by inflammation. (3: 429)

Tables (3 & 4) revealed the result of VO<sub>2</sub> max after an exhaustive exercise using the training unit maybe caused due to intensity of training and increased pulse rate at the same time.

Tschakovsky and Hughson (1999), Guyton and Hall (2006) reported that normal oxygen consumption for a young man at rest is about (250) ml/min, however under maximal condition this can be increased from (3600) ml/min of untrained male to (4000) ml/min of athletic trained male. (32: 1101), (18: 1061)

They added that both oxygen consumption and total pulmonary ventilation increase about (20) fold between the resting state and maximal intensity of exercise in the well trained athlete. (32: 1101), (18: 1061)

Tables (3 & 4) indicated an increased VO<sub>2</sub> max with increased intensity of exercise which is correlated with increased lactate concentration.

Mougiou (2006) stated that lactate is normally expressed as a percentage of individual VO<sub>2</sub> max has been used to predict performance in many events such as distance running, cycling and soccer matches but the lactate threshold in much more reliable. (27: 162)

While, Krusturup et al. (2006) examined lactate during a soccer game, they concluded that there was no correlation between the decline in sprint of the soccer players and musclelactate, PH or glycogen and that low glycogen explained the impair mint in sprinting at the end of soccer game. (24: 1165)

Tables (3 & 4) revealed that lactate concentration increased significantly after the exhaustive exercise together with an elevated level of creatine kinase, the increased in lactate concentration indicated an increased accumulation of lactate plus Hion concentration meaning increased acidity of the muscle, as for the increased creatine kinase, this maybe an indication of increased muscle damage.

The same result was approved by Kuipers (1994), Clarkson et al. (1992), Sorichter et al. (1999) they reported that muscle fatigue is associated with lactate plus Hion concentration, and muscle damage due to exercises for longer period is associated with increased creatine kinase concentration, chronically

stressed skeletal muscle shows abnormally increase biochemical substances likes lactate, creatin kinase and activated enzymes. (23: 132), (11:512), (30: 5)

Tables (3 & 4) revealed that decreased of minerals determination, sodium, potassium, calcium at the end of the exhaustive exercise, this decrease of minerals might be caused to their loss in the sweat.

Clausen (2003) reported that as much as (5) pound weight loss has been recorded in athletes in a period of one hour during endurance athletic events under hot and humid condition. (12: 1213)

Tanaka and Seals (2003) added that sweat contains large amount of sodium chloride for which reason, it has long been stated that all athletes should take sodium chloride tablets when performing exercise on hot and humid days. (31: 2152)

Heshmat et al. (2013), Besser and Thorner (2002), Boldyreff and Wehling (2004) reported a lower minerals concentration after an exhaustive exercise which maybe caused due to excess aldosterone leading to hypokalemia, reduced sodium and calcium which might lead to muscle weakness. (20: 338), (7: 75), (9: 97)

Tables (3 & 4) indicated an increased prolactin concentration after the exhaustive exercise protocol compared to the concentration at rest, this means that prolactin hormone which is secreted from the anteriorpituitary gland maybe sensitive to exercise stress, in this case it might be used as a marker of fatigue.

Hunters et al. (2003), Gratachea et al. (2007), Robergs et al. (2007) stated that in heavy physical work, fatigue was a consequence of sustained overload on the individual by energy expenditure, research shows an increase in energy expenditure after exercise session, this is related to the amount of exercise and their variations such as muscle groups, type of equipment, number of exercises and repetitions, load, execution time, exercise order and recovery time between sets. (21: 76), (16: 594), (29:123)

Goffin et al. (2002), Freeman et al. (2014) reported there is a relationship between exercise stress inducing fatigue and prolactin secretion and energy expenditure throughout exercise protocol. (17: 47),(14: 134)

As for cholinesterase enzyme, tables (3 & 4) reveals an elevated concentration of the enzyme indicating an increase release of acetyl choline the neurohormone which led to action potential and contraction of the muscle fibers.

Bohning and Snyder (2003) reported that acetyl choline is a neurotransmitter for the conduction of action potential, it is transported into its vesicles which release acetyl choline by nerve stimulation it is splitted to acetate and choline by the enzyme cholinesterase, then again inside the presynaptic terminal. (8: 105)

Allman and Rice (2002), Hock (2003), Lee (2003) stated that the vesicles are recycled from choline and acetate to form acetyl choline, they added that most of acetyl choline is destroyed by the enzyme cholinesterase and a small amount of acetyl choline diffuses out of the synaptic space and is not available to act on the muscular fibers. (1: 785), (22: 335), (25: 143)

Tables (3 & 4) revealed the level of hematocrit value before and after the exhaustive exercise and indicated an elevation of the hematocrit percent due to dehydration accompanying the exhaustive exercise.

Hatfield (2013) reported that hematocrit is the percentage of the blood that is cells and the average hematocrit value of men averages (42%) while that of woman (38%), These values vary tremendously depending on whether the person has anemia, on the degree of body activity and on the altitude at which the person resides or even the percent of dehydration, which in turn if persist may affect the viscosity of the blood as there are a relationship between both dehydration and increase viscosity of the blood and the number of cells in the blood. (19: 46)

The discussion indicated that the hypothesis that the exhaustive exercise till muscle fatigue might cause significant changes in the different variables indicating fatigue has been realized.

## Conclusion

Updated variables as... cholinesterase, hematocrit, prolactin, sodium, potassium and calcium can be used as indicators of muscle fatigue for soccer youngsters together with the classical variables as... VO<sub>2</sub> max, lactate, creatine kinase and pulse rate.

## Recommendation

It is recommended to use these variables as indicators of muscle fatigue for soccer youngsters due to the ease of measurement, also recommends to use it as a routine measurements to avoid the over load.

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