Effect of water and sport beverage intake on biochemical and physiological variables in trained wrestlers

Effetto dell’assunzione di acqua e bibite per lo sport sulle variabili biochimiche e fisiologiche in lottatori allenati

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SUMMARY

Aim. The aim of the present research was to investigate the effect of water and sport beverages on biochemical and physiological variables in trained wrestlers.

Methods. Twenty-one young trained freestyle wrestlers (mean age: 22.29±0.9 yr, weight: 75.45±12.9 kg and BMI 21.23±2.60) volunteered to participate in this research and were randomly divided into three groups: Group 1 (1 g D-glucose per 1 kg of body weight), Group 2 (water) and Group 3 (non-beverage). The subjects were required to perform a wrestling-technique based circuit exercise (WTBCE). The blood samples were gathered in three phases: before, immediately and 30 minutes after the exercise in order to measure plasma volume, Interleukin 6, testosterone and cortisol.

Results. The results showed that testosterone/cortisol (T/C) ratio was higher in Group 1 when compared with Group 2. It was also higher in Group 2 when compared with Group 3 (P<0.05). Plasma volume and Interleukin 6 (IL-6) were significantly lower and higher respectively in Group 3 when compared with Group 1 and 2 (P<0.05). Also, pressure perception was significantly higher in Group 3 when compared with Group 1 and 2 (P<0.05).

Conclusion. It can be concluded that if beverages are not consumed in wrestling intervals, it may cause not only negative physiological and biochemical effects, but also mental pressure on wrestlers so their sport performance may be negatively affected.

Keywords: Beverages - Testosterone - Hydrocortisone - Interleukin 6.
In recent decades, the importance of beverage intake during sport competitions which last one hour or more has been proved in different researches on beverage intake before, during or after these competitions.\textsuperscript{1-4} As perspiration is natural during sport competitions, it has been shown that for each kilogram of weight loss due to perspiration, one liter of body fluids will be lost, that is, the plasma volume in such athletes decreases twice as much as their weight loss.\textsuperscript{1, 5, 6}

It has been shown that if body fluid decrease is not quickly replaced in intensive exercises, athletes’ body will dehydrate and plasma volume will decrease.

Dehydration, even if it is slight (2% of body weight), can negatively affect the athletes’ muscular and physiological performance in these ways: an increase in heart rate and body internal temperature and a decrease in heart output.\textsuperscript{1, 2, 5, 6}

However, if dehydration decrease reaches about 3% of body weight, it can have more devastating effects such as damage to lymphocyte DNAs and an increase in free radicals. All the above points can affect athletes’ efficiency by some proved mechanisms.\textsuperscript{7}

There is not much evidence for the effect of beverage intake on sport performance in sports which last under one hour. There are no researches on sport fields which last under 30 minutes and especially those short time fields such as wrestling and judo. One reason can be of lack of attention to this issue is the World Wrestling Federation.

The intake of water or sport beverages containing carbohydrates can maintain plasma volume.\textsuperscript{1, 2, 9, 10} Carbohydrate can be considered not only as a substrate to produce energy and to maintain performance, but also as a mediator to facilitate the absorption of consumed beverages and electrolytes and to improve performance.\textsuperscript{1, 10-15}

As researches on beverage intake during sport competitions focus on endurance activities as well as activities with various intensities and the competitions which last 30 minutes and more and as wrestling is very popular with the Iranian youth, it seemed essential to conduct a research on the effect of beverage intake during wrestling competitions as the beverage intake is forbidden during these competitions and as a result, it is probable that negative physiological effects develop.
Materials and methods

Subjects

Twenty-one young freestyle wrestlers (age 22.29±0.9 yr, weight 75.45±12.9 kg and BMI 21.23±2.60) were voluntarily selected from well-trained national level wrestlers of Khorasan province who constantly experienced at least five years of training and gained three provincial or national medals. Then, they were randomly divided into three groups (N.=7): Group 1: beverage containing carbohydrate (1 g D-glucose per 1 kg of body weight), Group 2: water and Group 3: control (non-beverage).

General procedures

The subjects of all groups were required to perform a wrestling-technique based circuit exercise (WTBCE).16, 17 This protocol consisted of eight wrestling technique stations with a five-meter distance between each two stations. Each subject had to promptly perform a technique at one station, run to the next station and perform the next technique until the first two minutes finished. There was a 30-second rest and then the performance continued in three times (like a wrestling competition). In every rest between times, Group 1 received 1 g. D-glucose/100 cc water per 1 kg of body weight, Group 2 received 100 cc of water and Group 3 received no beverages. The mentioned protocol produced lactic acid and heart rate in a similar way to wrestling.16, 17 As the researcher could not accurately measure the pressure on the subjects during the wrestling, a substitute method was used to control the exercise pressure by the time and the number of techniques performed.

Detection methods

The blood samples were gathered before, immediately and 30 minutes after the performance. The samples were used to measure plasma volume,18, 19 interleukin 6, testosterone and cortisol (ELISA and RIA method). Maximal heart rate was measured by Polar heart rate monitor, pressure perception by Borg scale and body temperature by thermometer at the end of each time. SPSS was used to analyze the data, Kolmogorov-Smirnov test to investigate data homogeneity, paired sample t test to compare pretest and post-test in each group and one-way ANOVA to compare the variables between groups.

Materiali e metodi

Soggetti

Ventuno giovani lottatori di lotta libera (età 22.29±0.9 anni, peso corporeo 75.45±12.9 kg e IMC 21.23±2.60) sono stati selezionati in maniera volontaria da lottatori di livello nazionale ben allenati della provincia di Khorasan, i quali si erano allenati costantemente per almeno cinque anni e avevano vinto tre medaglie in competizioni provinciali o nazionali. Successivamente, i lottatori sono stati assegnati in maniera casuale a tre gruppi (N.=7): Gruppo 1: bibita a base di carboiodrati (1 g di D-glucosio per 1 kg di peso corporeo), Gruppo 2: acqua, Gruppo 3: controllo (nessuna bibita).

Procedure generali

Ai soggetti di tutti i gruppi è stato chiesto di effettuare un esercizio a circuito basato sulla tecnica di wrestling.16, 17 Tale protocollo prevedeva otto stazioni nelle quali veniva effettuata una tecnica di wrestling, con una distanza di cinque metri tra una stazione e l'altra. Ogni soggetto doveva prontamente effettuare una tecnica in una stazione, correre alla stazione successiva ed effettuare la tecnica successiva fino al termine dei primi due minuti. Vi è stato un riposo di 30 secondi e successivamente la performance è proseguita in tre tempi (come in un incontro di wrestling). In ogni riposo tra i tempi, il Gruppo 1 ha ricevuto 1 g. D-glucosio/100 cc acqua per 1 kg di peso corporeo, il Gruppo 2 ha ricevuto 100 cc d’acqua e il Gruppo 3 non ha ricevuto nessuna bibita. Il protocollo menzionato ha generato produzione di acido lattico e una frequenza cardiaca simile a quelle delle competizioni di wrestling.16, 17 Poiché il ricercatore non poteva misurare accuratamente la pressione sui soggetti durante il wrestling, è stato utilizzato un metodo sostitutivo per controllare la pressione dell’esercizio fisico per il tempo e il numero di tecniche effettuate.

Metodi di rilevazione

I campioni di sangue sono stati raccolti prima, immediatamente dopo e 30 minuti dopo la performance. I campioni sono stati utilizzati per misurare il volume di plasma18, 19, l’interleuchina 6, il testosterone e il cortisolo (metodi ELISA E RIA). La frequenza cardiaca massima è stata misurata mediante il cardiofrequenzimetro Polar, la percezione della pressione mediante la scala di Borg e la
Results

After no significant difference was observed in data between the pretest and posttest, there was a significant increase in T/C in all groups immediately after the performance when compared with the ratio before the performance (P<0.05). There was a significant increase in the average T/C in Group 1 and 2, 30 minutes after the performance when compared with the average ratio before and immediately after the performance while there was no significant change in the average T/C in Group 3, 30 minutes after the performance when compared with the average ratio immediately and before the performance (Table I).

There was a significant increase in T/C immediately and 30 minutes after the training in Group 1 when compared with Group 2 and in

<table>
<thead>
<tr>
<th>Testosterone/cortisol Ratio 30 min post</th>
<th>Testosterone/cortisol Ratio immediately post</th>
<th>Testosterone/cortisol Ratio pre</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>73.96±5.4*#</td>
<td>64.65±5.3*</td>
<td>55.84±3.6</td>
<td>WGB</td>
</tr>
<tr>
<td>59.3±4.06*#</td>
<td>57.58±3.6*</td>
<td>53.24±3.6</td>
<td>WB</td>
</tr>
<tr>
<td>50.99±3.9</td>
<td>50.92±3.9*</td>
<td>50.68±4.02</td>
<td>NB</td>
</tr>
</tbody>
</table>

*: comparison of pre and postvalues, P<0.05; #: comparison of pre and 30 minutes postvalues, P<0.05.

Risultati

Non è stata osservata nessuna differenza significativa nei dati tra pre-test e post-test, ma vi è stato un aumento significativo nel T/C in tutti i gruppi immediatamente dopo la performance rispetto al rapporto precedente alla performance (P<0.05). Vi è stato un aumento significativo nel T/C medio nei Gruppi 1 e 2 trenta minuti dopo la performance...
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ce rispetto al rapporto medio prima e immediatamente dopo la performance, mentre non vi è stata nessuna variazione significativa nel T/C medio nel Gruppo 3 trenta minuti dopo la performance rispetto al rapporto medio immediatamente prima e prima dell’allenamento (Tabella 1).

Vi è stato un aumento significativo nel T/C immediatamente dopo e 30 minuti dopo l’allenamento nel Gruppo 1 rispetto al Gruppo 2 e nei Gruppi 1 e 2 (che hanno ricevuto bibite nel loro intervallo di riposo) rispetto al Gruppo 3 (che non ha ricevuto bibite) (P<0.05) (Figura 1).

Vi è stato un aumento significativo nell’interruzione 6 (IL-6) nel Gruppo 3 rispetto ai Gruppi 1 e 2 e nel Gruppo 2 rispetto al Gruppo 1 (P<0.05) (Figura 2).

Vi è stata una leggera (non significativa) riduzione del volume di plasma nei Gruppi 1 e 2, mentre è stata osservata una riduzione significativa (4%) nel Gruppo 3 (P<0.05) (Figura 3).

Discussion

As the results showed, T/C was lower in Group 3 (who received no beverages in their rest interval) than the other two groups. Endocrine system is suggested as an important factor when responding to training pressure and the balance between catabolism and anabolism depends on T/C.20 A significant relationship was observed between testosterone and competitive performance and testosterone can predict real changes in the performance during a competition.21

Also, the strength of skeletal muscle affects the performance and plays a vital role in different sport fields; especially in strength fields such as wrestling. It has been shown that T/C plays an important role in sport performance.22, 23 Previous studies showed that if the subjects dehydrate, noradrenaline and cortisol increase and as a result

Figure 3.—Plasma volume changes. Pre-, immediately post- and 30 minutes after exercise in WGB, WB and NB groups.

Figura 3. — Variazioni nel volume di plasma. Prima, immediatamente dopo e 30 minuti dopo l’esercizio fisico nei gruppi con WBC (bibita a base di acqua e glucosio), WB (bibita di acqua) e NB (nessuna bibita).
the athletes will be under stress. Also, as cortisol increases, T/C decreases which can result in a decrease in wrestlers’ performance. Muscle strength can be affected by hypothalamus – hypophysis – gonad in addition to growth hormone – IGF1, an increase in testosterone stimulates IGF1 secretion and as a result an increased IGF1 leads to higher levels of performance during a competition. It can be concluded that if wrestlers do not receive beverages when performing a short-term protocol, such as wrestling competition, their performance can be negatively affected as were seen in group 3. This was considered by their incorrect performance of wrestling techniques. Also, an increase in T/C in Group 1 when compared with Group 2 shows that carbohydrate ingestion together with beverages may result in a better hormonal ratio and as a result better performance of wrestlers. In addition, many researches have indicated the positive effect of carbohydrates in long-term exercises. However, Yaspelkis et al. showed that carbohydrate supplementation together with sport beverages during cycling intensity exercises can result in a decreased muscle glycogen breakdown and improved performance. Therefore, it can be expected that Group 1 will show a better performance especially in the last time of performance and in group 3 (with no beverage), decrease in T/C ratio probably can lead to decrease of performance because of decrease in muscle glycogen stores.

Interleukin-6 is an inflammatory cytokine and an increased IL-6 is an indicator of increased inflammation, stress pressure on body and decreased muscle glycogen reserves. Robson et al. (2010) showed that carbohydrate ingestion during prolonged exercise can result in a decreased plasma IL-6 when compared with non-CHO group.

In Group 1 (carbohydrate plus water), IL-6 was considerably lower than the other two groups which shows that beverage and carbohydrate intake can be considered as a substrate for metabolism during exercise as well as a factor to prevent inflammation and discharge of muscle glycogen. This will be very important if the wrestlers intend to maintain their performance during competitions. Then it can be expected that subjects of group 1 who received CHO and water during exercise, experience less discharge of muscle glycogen and thus better performance as IL-6 was lower than other groups, while subjects of group 3 (no beverages) showed more increase of IL-6, that is probably one of the main factors of wrestlers’ performance during competitions. Then it can be expected that Group 1 will show a better performance especially in the last time of performance which is the observation in this study. However, another observation has shown that carbohydrate ingestion together with beverages may result in a better hormonal ratio and as a result better performance of wrestlers. In addition, many researches have indicated the positive effect of carbohydrates in long-term exercises. However, Yaspelkis et al. showed that carbohydrate supplementation together with sport beverages during cycling intensity exercises can result in a decreased muscle glycogen breakdown and improved performance. Therefore, it can be expected that Group 1 will show a better performance especially in the last time of performance and in group 3 (with no beverage), decrease in T/C ratio probably can lead to decrease of performance because of decrease in muscle glycogen stores.

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ably because of decrease in muscle glycogen stores and may lead to poor performance especially in last times of intensive exercises as were seen in group 3.

Another finding showed that plasma volume slightly decreased in Group 1 and 2, this decrease was not significant but in Group 3, a significant decrease (4%) was observed in plasma volume (P<0.05). As decreased plasma volume can negatively affect sport performance by proved mechanisms.\(^1,2,5,6,34\) It has been well known that hypovolemia induced by dehydration leads to excessive heat storage and hyperthermia has been suggested to limit competitive performance.\(^34\) It is expected that Group 3 will face a decreased performance during the competition.

In other words, fluid intake especially beverages containing carbohydrate can improve wrestlers' performance through maintenance of muscle fuel especially glycogen\(^10\) blood volume and viscosity\(^1,2,5,6\) during exercise; then probably it is expected that, wrestlers of group 2 and 1 that ingest beverage during exercise may have better homeostasis in blood volume and performance while wrestlers of group 3 because of hypovolemia may suffer and have poor competitive performance.

**Conclusions**

It can be concluded that if beverages are not received during the rest intervals, the wrestlers may face negative physiological and biochemical effects as well as mental pressure which in turn may negatively affect their sport performance. Also, as researches have shown that if athletes receive sufficient fluids, they will replace some amount of their lost fluids and as each wrestler participates in several competitions with short intervals in one day, it is probable that they replace their body fluids if they are allowed.

It is suggested that wrestlers are allowed to drink beverages in their rest intervals; 1 g. D-glucosio per 1 kg of body weight / 100 cc water is suggested for better performance as well.

plasma is diminished leggermente nei Gruppi 1 e 2; tale diminuzione non era significativa ma nel Gruppo 3 è stata osservata una diminuzione significativa (4%) nel volume di plasma (P<0.05). Un ridotto volume di plasma può influenzare in maniera negativa la performance sportiva mediante meccanismi dimostrati\(^1,2,5,6,34\) ed è noto che l’ipovolemia indotta dalla disidratazione conduce a un eccessivo immagazzinamento di calore, mentre è stato suggerito che l’ipertermia limiti la performance competitiva.\(^34\) Si prevede che il Gruppo 3 avrà una performance ridotta durante la competizione.

In altre parole, l’assunzione di liquidi, soprattutto bibite a base di carboidrati, può migliorare la performance dei lottatori attraverso il mantenimento del carburante muscolare, in particolare il glicogeno\(^10\), il volume ematico e la viscosità\(^1,2,5,6\) durante l’esercizio fisico; quindi, è probabile che i lottatori dei Gruppi 2 e 1 che assumono bibite durante l’esercizio fisico avranno una migliore omeostasi nel volume ematico e una migliore performance mentre i lottatori del Gruppo 3 a causa dell’ipovolemia potrebbero soffrire e avere una scarsa performance competitiva.

**Conclusioni**

Si può concludere che la mancata assunzione di bibite durante gli intervalli di riposo può generare effetti fisiologici e biochimici negativi nei lottatori, oltre che una pressione mentale che a sua volta può influenzare in maniera negativa la loro performance sportiva. Inoltre, i ricercatori hanno mostrato che, se gli atleti ricevono liquidi a sufficienza, essi sosterranno una certa quantità dei loro liquidi perduti; inoltre, poiché ogni lottatore partecipa a diverse competizioni con brevi intervalli nel corso di una giornata, è probabile che egli/ella reintegri i propri liquidi corporei se gli verrà consentito di farlo.

Si suggerisce pertanto di permettere ai lottatori di bere bibite durante i loro intervalli di riposo. Anche 1 g di D-glucosio per 1 kg di peso corporeo / 100 cc acqua è suggerito per ottenere una migliore performance.

**References/Bibliografia**


