

Influence of Acute Exercise on Urinary Protein, Creatinine, Insulin-Like Growth Factor-I (IGF-I) and IGF Binding Protein-3 Concentrations in Children

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TURGUT, G., KAPTANOĞLU, B., TURGUT, S., GENÇ, O. and TEKİNTÜRK, S. *Influence of Acute Exercise on Urinary Protein, Creatinine, Insulin-Like Growth Factor-I (IGF-I) and IGF Binding Protein-3 Concentrations in Children.* Tohoku J. Exp. Med., 2003, **201** (3), 165-170 — Insulin-like growth factor-I (IGF-I) is a polypeptide hormone and present in human urine. Insulin-like growth factor binding protein-3 (IGFBP-3) is the major form of binding protein in human circulation and functions as a carrier for IGF-I. Our goal was to determine the effects of volleyball exercise on the concentrations of urine protein, creatinine, IGF-I, and IGFBP-3 in children and to find out whether these effects differ between boys and girls. Volunteer children (13 females and 14 males), aged 10-13 years old were included in this work. Weight and height of the subjects were measured, and urine samples of their were collected before and after 2 hours of exercise. Urinary protein, creatinine, IGF-I and IGFBP-3 levels were analysed. Urinary protein, creatinine and IGF-I concentrations were increased after two hours of exercise whereas urinary IGFBP-3 concentrations did not change. In addition, no statistically significant difference in all parameters analysed was observed between boys and girls of similar age and body mass index. ——— insulin-like growth factor-I (IGF-I); insulin-like growth factor binding protein-3 (IGFBP-3); protein; creatinine; exercise

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Insulin-like growth factor I (IGF-I) is a 70-amino-acid single chain polypeptide hormone (7.65 kDa) with similar structural features to insulin (Isaksson et al. 1991). It is produced in many tissues of the body primarily in the liver

(Daughaday and Rotwein 1989) and present in human urine (Hizuka et al. 1987). IGF-I plays an important role in the growth hormone/insulin-like growth factor (GH/IGF) pathway (Well 1998; Rosen and Pollak 1999), which is

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important in the maintenance of skeletal muscle mass and function in adults (Baum et al. 1996). This pathway influences and is influenced by physical exercise (Jenkins 1999). Biochemical actions of growth hormone are multiple, and most of the growth and metabolic effects of this hormone are mediated by a peptide hormone, i. e., IGF-I (Le Roith 1997).

IGF-I circulates bound to specific proteins (Insulin-like growth factor binding proteins; IGFBPs), which regulate its bioavailability and bioactivity (De Palo et al. 2001). The IGFBPs form a family of six high affinity carriers (IGFBP-1 through IGFBP-6) for IGFs that are present in serum and in other extracellular fluids (Clemmons 1993). IGFBPs modulate the interaction of IGF-I with its receptor (Ocran et al. 1990).

IGFBP-3 is a 264 amino acid glycoprotein (29 kDa) synthesized in the liver and in other tissues, with a 27 amino acid signal peptide and 18 cysteine residues (Ballard et al. 1989). It is a major carrier in human circulation for IGF-I and -II, whose actions may be inhibited and/or enhanced (Rajaram et al. 1997). IGFBP-3 both protects IGF-I from degradation and lowers the free concentration of IGF-I (Collett-Solberg and Cohen 1996).

In this study we aimed to investigate the effects of exercise on the concentrations of urine protein, creatinine, IGF-I, and IGFBP-3 in children and to find out whether these effects are different between boys and girls.

MATERIALS AND METHODS

Volunteer children who were in the school volleyball team were included in this work, consisting of 13 females and 14 males aged 10–13 years old. Both children and their trainers were acknowledged about the study, and written informed consent was obtained from each individual. We conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki) in this study. Weight and height of the children were measured.

Urine samples of sportsmen were collected before and after 2 hours of exercise. The exercise was applied in two periods of 1 hour each with 15 minutes rest. First urine samples were obtained at 9:00 while second ones at 11:30 o'clock. The exercise consisted of heating, running and standard volleyball exercise (e.g., serving, jumping).

Urine protein and creatinine concentrations were analysed with commercial kits (Abbott, Chicago, IL, USA) by an autoanalyzer (Aeroset, Chicago, IL, USA) while urine IGF-I and IGFBP-3 concentrations with ELISA kits (Diagnostic System Laboratories, Webster, TX, USA) by using an autoanalyzer (Labotech, Rome, Italy).

The results were evaluated with Wilcoxon test for concentration differences before and after exercise within the same group. The differences in all parameters between boys and girls were made with Mann Whitney's U-test by using a computerized SPSS 9.0 program (Statistical Package for Social Sciences). Data are expressed as mean \pm S.D.

RESULTS

Mean ages of 13 girls and 14 boys were 10.69 ± 0.93 and 10.42 ± 0.64 (totally 10.55 ± 0.80), respectively. Mean weight and height of children were measured to be 39.44 ± 10.13 kg and 147.48 ± 8.16 cm, respectively, and body mass index (BMI) of them were calculated as 17.94 ± 3.24 kg/cm², being 17.50 ± 2.23 for girls and 18.35 ± 4.00 for boys. No statistically significant difference was found between age and BMI of both gender.

Table 1 summarized the significant increases in the concentrations of urine protein, creatinine and IGF-I in both boys and girls after exercise, except for IGFBP-3 concentrations. Table 2 shows the results for those of girls, and Table 3 for boys. There was no sex difference in the concentrations of urine protein, creatinine, IGF-I, and IGFBP-3 before and after exercises.

TABLE 1. *Urinary protein, creatinine, IGF-I and IGFBP-3 concentrations in children before and after exercise (mean \pm s.d.)*

	Before exercise (n=27)	After exercise (n=27)
Protein concentrations (mg/100 ml)	9.58 \pm 6.51	21.68 \pm 15.63***
Creatinine concentrations (mg/100 ml)	93.15 \pm 49.77	187.60 \pm 102.70***
IGF-I concentrations (ng/liter)	135.92 \pm 153.10	312.51 \pm 209.84**
IGFBP-3 concentrations (ng/liter)	172.59 \pm 36.08	159.29 \pm 44.45

** $p < 0.01$, *** $p < 0.001$.

TABLE 2. *Urinary protein, creatinine, IGF-I and IGFBP-3 concentrations in girls before and after exercise (mean \pm s.d.)*

	Before exercise (n=13)	After exercise (n=13)
Protein concentrations (mg/100 ml)	9.71 \pm 6.17	26.48 \pm 18.95**
Creatinine concentrations (mg/100 ml)	98.74 \pm 55.50	201.55 \pm 121.37**
IGF-I concentrations (ng/liter)	140.00 \pm 168.86	270.69 \pm 202.73*
IGFBP-3 concentrations (ng/liter)	161.38 \pm 34.21	169.38 \pm 36.70

* $p < 0.05$, ** $p < 0.01$.

TABLE 3. *Urinary protein, creatinine, IGF-I and IGFBP-3 concentrations in boys before and after exercise (mean \pm s.d.)*

	Before exercise (n=14)	After exercise (n=14)
Protein concentrations (mg/100 ml)	9.45 \pm 7.05	17.22 \pm 10.62**
Creatinine concentrations (mg/100 ml)	87.96 \pm 45.28	174.64 \pm 84.38***
IGF-I concentrations (ng/liter)	132.14 \pm 143.26	351.35 \pm 216.23*
IGFBP-3 concentrations (ng/liter)	183.00 \pm 35.79	149.92 \pm 50.12

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

DISCUSSION

We observed a significant increase in the concentrations of urine protein and creatinine of both boys and girls after exercises. It has been reported that heavy exercise cause a glomerular/tubular mix type proteinuria due to the increase of glomerular filtration permeability and proximal tubular reabsorption saturation of filtrated proteins in healthy adults (Poortmans and Vanderstraeten 1994). A temporary functional disorder was observed in both glomerular and tubular parts of nephron after exercise in all ages of children (Poortmans et al. 1996). Post-exercise increases in proteinuria occur fol-

lowing the physiological stress of intense exercise, most likely as a result of the exercise induced blood acidity changes, which lead to a change in the arrangement of the albumin molecule (Montelpare et al. 2002). Our results seem to be correlated with the literature. There was no significant difference in the increases of urine protein and creatinine concentrations after two hours of volleyball exercise between boys and girls who were at similar age and had similar BMI in our study.

The physical exercise type is able to influence GH metabolism with the stimulation of IGF synthesis and release of its binding proteins (De Palo et al. 2001). An increase in urine GH

excretion following exercise has been described (Flanagan et al. 1997; De Palo et al. 1998). Although the exact origin of urinary IGF-I is unknown (De Palo et al. 2002), it could be used as a valid surrogate for serum IGF-1 in the physiological assessment (Hall et al. 1999). The amount of IGF-I excreted into the urine was easily accounted for by what is filtered, inferring that serum IGF-I is the source of urinary IGF-I (Guler et al. 1989), but local production cannot be ignored (Aron et al. 1989; Chin and Bondy 1992). Serum IGF-I response to physical exercise has been a controversial issue; some research groups have observed increments, while others showed no variations (Di Luigi et al. 1997; Nguyen et al. 1998; Wallece et al. 1999). We found a significant increase in the concentrations of urine IGF-I after exercise in our study. This increase, as stated by De Palo et al. (2002), might be in relation with post-exercise proteinuria. In addition, De Palo et al. (2002) stated that further investigation should confirm this observation and we performed the study on a different type and duration of an exercise and found the same results like those of them. On the other hand we found no difference in the urinary IGF-I excretion rate after exercise between boys and girls.

Serum IGF-I and IGFBP-3 concentrations were found to be higher at the end of incremental ergometer cycling to exhaustion in one study (Nguyen et al. 1998). In other studies, serum IGFBP-3 increased immediately after a short-term exercise on a cycle ergometer, both at low and high intensity (Schwarz et al. 1996; Wallece et al. 1999), whereas acute effects on serum IGFBP-3 concentration were observed neither immediately after a marathon run (Koistinen et al. 1996) nor after a long-distance Nordic ski race (Nguyen et al. 1998). In our study, there was no statistically significant difference in the concentration of urinary IGFBP-3 before and after exercise. The discrepancies between different studies are prob-

ably due to the factors that influence also the IGF system response to exercise and or training (i.e., gender, age, training status, type, duration and intensity of exercise, nutrition, hormonal status, etc.). Our study, together with the difference in the type and time of the exercise, is important for the confirmation of previous researches (De Palo et al. 2001, 2002; Di Luigi and Guidetti 2002) in terms of urinary IGFBP-3 measurement.

CONCLUSION

Our study confirm that urinary protein, creatinine and IGF-I concentrations of children aged 10 to 13 years old increased but urinary IGFBP-3 concentrations did not change after two hours of volleyball exercise. Moreover, no statistically significant difference in all parameters analysed was observed between boys and girls who were at similar age and had similar BMI.

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