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Original

RESPUESTA DE LA HORMONA DE CRECIMIENTO AL EJERCICIO AGUDO CANGURO 'FUN FOR FITNESS' EN PESO NORMAL Y NIÑOS Y NIÑAS OBESOS

GROWTH HORMONE RESPONSE TO ACUTE KANGAROO 'FUN FOR FITNESS' EXERCISE IN NORMAL-WEIGHT AND OBESE BOYS AND GIRLS

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RESUMEN

El propósito de este estudio era evaluar las diferencias en las respuestas de GH al ejercicio canguro entre niños con peso normal y obesos en ambos sexos.

Métodos: Los niños (de 11.280,54 años) se dividieron en; niños de peso normal (N=17), niños obesos (N=13), niñas de peso normal (N=15) y niñas obesas (N=9). Todos los participantes hicieron ejercicios canguro con 9 saltos, para un total de 7 juegos de diez repeticiones para cada pierna. Antes y después del ejercicio, los participantes fueron medidos para sus concentraciones séricas de GH.

Resultados: Los resultados mostraron que las niñas (tanto de peso normal como obesas) tenían una concentración sérica de GH más alta que los niños antes y después del ejercicio (todos, $p < 0.05$). No hubo diferencias entre los grupos de peso normal (ambos sexos) y obesos en la prueba previa ($p > 0.05$). Sin embargo, en una prueba posterior, el peso normal (ambos sexos) tuvo una concentración sérica de GH más alta que los grupos obesos ($p < 0.05$). Además, los grupos de peso normal presentaron una concentración sérica de GH post-ejercicio más alta que la pre-ejercicio ($p < 0.05$). Por el contrario, los grupos obesos presentaron una concentración sérica de GH post-ejercicio más baja que la pre-ejercicio ($p < 0.05$).

Conclusión: Los niños y niñas obesos presentaron una disminución de las respuestas agudas de GH al ejercicio de canguro. Los niños y niñas obesos mostraron concentraciones séricas de GH más bajas después del ejercicio en comparación con los niños y niñas de peso normal.

Palabras clave: Ejercicio canguro, hormona de crecimiento, peso normal, obesidad, ejercicio canguro, concentración de GH

ABSTRACT

The purpose of this study was to evaluate differences in the GH responses to Kangaroo exercise between normal-weight and obese children in both genders.

Methods: Children (aged 11.28±0.54 y) were divided into; normal-weight boys (N=17), obese boys (N=13), normal-weight girls (N=15), and obese girls (N=9). All participants did Kangaroo exercises with 9 jumps, for a total of 7 sets of ten repetitions for each leg. Before and after exercise, participants were measured for their serum GH concentrations. Results:

The results showed that girls (both normal-weight and obese) had a higher serum GH concentration than boys at pre-exercise and post-exercise (all, $p < 0.05$). There were no differences between normal weight (both genders) and obese groups at pre-test ($p > 0.05$). However, at a post-test, normal weight (both genders) had a higher serum GH concentration than the obese groups ($p < 0.05$). Moreover, normal-weight groups presented a higher post-exercise serum GH concentration than the pre-exercise ($p < 0.05$). In contrast, the obese groups presented a lower post-exercise serum GH concentration than the pre-exercise ($p < 0.05$).

Conclusion: Obese boys and girls presented diminished acute GH responses to kangaroo exercise. Obese boys and girls displayed lower serum GH concentrations at post-exercise as compared to normal-weight boys and girls.

Keywords: Kangaroo exercise, Growth hormone, Normal-weight, Obesity, Kangaroo exercise, GH concentration

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INTRODUCTION

It is known that growth hormone (GH) is a vital figure that directs development and improvement amid childhood and youth (Fanciulli et al., 2009; Veldhuis et al., 2006). Exercise could be a strong boost to GH discharge in people (Cappon et al., 1994; Ignacio et al., 2015; Wideman et al., 2002; Wideman et al., 1999). Both acute aerobic and resistance exercises can increase in GH release (Pritzlaff-Roy et al., 2002; Pritzlaff et al., 2000; Weltman et al., 2008; Wideman et al., 2002). Exercise intensity is related to GH discharge in a straight relationship; in any case, the relationship is impacted by sex (Pritzlaff-Roy et al., 2002; Weltman et al., 2006; Wideman et al., 2006). Boys and girls are diverse within the GH reaction to work out (Giustina & Veldhuis, 1998; Wideman et al., 1999). At rest, ladies have higher serum GH concentrations than men (Wideman et al., 2000; Wideman et al., 1999). During exercise, they have a comparative design of increment in serum GH concentrations (Giustina & Veldhuis, 1998; Pritzlaff-Roy et al., 2002), but ladies will achieve top serum GH concentrations sooner than men (Wideman et al., 1999). However, the increase from baseline is significantly higher for men than women (Giustina & Veldhuis, 1998).

In addition, obesity reduces serum GH concentrations (Kanaley et al., 1999; Veldhuis et al., 1995; Weltman et al., 2008). GH reacts to a lesser degree to intense work out in obese than lean people (Hansen et al., 2012). At rest, obesity contrarily influence the concentrations of GH (Trabert et al., 2012). Obese people have a lower recurrence of serum GH concentrations and higher clearance rates (Johannsson et al., 1997). A recent study in early pubertal normal-weight and obese boys found that aerobic exercise could increase serum GH concentrations in both groups; but obese boys demonstrated lower serum GH concentrations than normal-weight boys both at baseline and after an acute bout of aerobic exercise (Paltoglou et al., 2015). Similarly, studies on resistance exercise found that a lower GH reaction was watched in obese compared to lean sedentary men (Ormsbee et al., 2009; Thomas et al., 2011). At rest, young active obese men had lower serum GH concentrations as compared to young lean active men. Immediately post-exercise, there were no contrasts between lean and obese males within the increment of serum GH concentrations in reaction to resistance work out from pre-exercise to post-exercise (Rubin et al., 2015).

It is known that intermittent work out is as successful as conventional continuous work out, especially in obesity (Donnelly et al., 2000) and may have advantage for a GH discharge. A study found that 10 mins of high-impact work out may invigorate GH discharge (Cappon et al., 1994). To inspire an introductory rise in GH discharge, it was recommended that work out ought to have an extend of times between 10 mins to 15 mins (Sauro & Kanaley, 2003; Stokes et al., 2005). A recent study found that combined strength and endurance work out can increment the quick post-exercise GH discharge (Rosa et al., 2015).

Kangaroo exercise is an intermittent strength and endurance exercise with 9 jumps and is controlled by the intensity and duration of the music. It was developed to be used as a fitness program for Thai students nationwide, under the project "Kangaroo 'Fun for Fitness' exercise". In the year 2018-2019, there was an annual kangaroo dance competition which was organized by the department of health, ministry of public health, Thailand. From inquiring about the benefits of kangaroo exercise, teachers and students reported that kangaroo exercise might help children's bodies to increase their heights due to jumping. Thus, evaluating the change in serum GH concentrations due to kangaroo exercise was of interest. For this reason, the purpose of this study was to evaluate the differences in the serum GH responses to kangaroo exercise between early pubertal normal-weight and obese boys and girls. The benefits from this study would help to develop kangaroo exercise styles that are appropriate for children.

METHODS

Participants

All of the children (220 in total) in the sixth grade of Tak kindergarten school which is a public school in a city neighborhood, Thailand (aged 11.28±0.54 y) were initially enrolled in this study. Participants were selected by the following inclusion criteria, (i) no health condition and can participate in kangaroo exercise, and (ii) normal-weight or obesity, their body weights were calculated and compared with the standard criteria for growth of Thai children's curves, according to the department of health, ministry of public health, Thailand. Only healthy normal-weight (N=32) and obese (N=22) boys and girls from the examined school classes were included in this study. Participants were considered normal-weight or obese when their projected weight and height values for their ages were in a normal zone or obese zone, respectively. The normal zone Indicated that the child had a weight suitable for one's height. Thus, weight according to height criteria could be an indication of underweight, normal-weight, overweight or obesity. This study was approved by the Institutional Review Board at Srinakharinwirot University, Thailand. An informed written consent was obtained from the parents/guardians of each child while the children gave verbal consents to participate in the study.

Procedures

A quasi-experimental pretest-posttest design was used. The protocol was performed in three visits separated by 1-3 days in a gymnasium of Tak kindergarten. First visit was subject selection. All 220 boys and girls were examined for their weights and heights by the researcher teams. Participants had their body weight measured to the nearest 0.1 kg (Beam Balance 710; Seca, Birmingham, UK) while they were in school uniform. Barefoot standing height was measured to the nearest 0.1 cm (Stadiometer 208; Seca, Hanover, MD), and their BMI was calculated [BMI = weight (kg)/height (m^2)]). Subsequently, from the 220 originally recruited normal-weight and obese boys and girls. Four groups of subjects were formed: (i) normal-weight boys (N=17), (ii) obese boys (N=13), (iii) normal-weight girls (N=15), and (iv) obese girls (N=9). Second visit was a kangaroo exercise practice. During the second visit, selected normal-weight and obese boys and girls were taught how to do kangaroo exercise for about 1 hour. Participants were asked to sleep a minimum of 7 hours the previous night and to avoid any strenuous exercise at least twenty-four hours before the trial. The third visit was an experimental trial. During the third visit, all participants have had measured their characteristics and GH, 10 minutes before and 15 minutes after 12 minutes of kangaroo exercise.

Upon arrival at the gymnasium (3rd visit), 5 mins of seated rest commenced, after which resting heart rate (HR) was measured through a heart rate monitor, and systolic (SBP) and diastolic (DBP) blood pressures were obtained via a mobile aneroid sphygmomanometer cuff (Diagnostic 752, American Diagnostic Corporation, Hauppage, NY). The kangaroo exercise trials were completed between 1:00 and 2:00 pm. After the participants' characteristics (i.e., age, weight, height, and RHR) have been measured, participants rested for 5 mins before a pre-exercise (PRE) blood sample was obtained and, the participants performed 5-mins of warm-up, followed by one set of 10 upper and lower body stretches held for 10 s; (stretches focused on the shoulder, quadriceps, hamstrings, and calves).

Immediately after the participants have completed their stretching exercise, the protocol then consisted of nine kangaroo exercises for a total of 7 sets of ten repetitions with each leg, 12 minutes in total. Participants were instructed to perform the exercise at a steady pace of 2-3 s per step up, thus completing 20 step-ups (ten with each leg) in about 40 to 60 seconds. Between sets, participants rested for 30 seconds while standing up and were allowed to drink water during this break. A second blood sample was collected 15 mins after the exercise has been completed (POST). This sampling time was chosen to capture GH changes upon cessation from exercise as well as in recovery (Kraemer & Ratamess, 2005).

Kangaroo exercise

One set of kangaroo exercises includes 9 jumping exercises; that is jumping jacks, jumping grapevine, jumping knee up, jumping ta-kraw kick, jumping kick the butt, jumping scissors, jump footswitch, and jumping backward. Children did kangaroo exercises with a partner for 12 minutes. The intensity of the exercise was 70-80% heart rate reserve (HRR). To control the intensity, the average HRR of the sample was used. Controlling the intensity of the jump to the specified intensity was done by measuring the heart rate with the chest strap and showing the result via the wrist watch. The children themselves were responsible for looking at their watch and then adjusting their intensity accordingly. Before exercise, the participants consumed foods that were easily digested within 2-3 hours before the test. After that, refrain from eating any food and rest, but could drink water as needed until the test time. Before the exercise, warm up and stretch the muscles with the

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kangaroo posture for 3 minutes and after the exercise, cool down for 5 minutes.

Blood processing and analysis

The blood sample collection was conducted in a standardized manner by 2 medical technicians from King Taksin Hospital. Blood samples were drawn from the veins of the right and left sides of the forearm (Median cubital vein), with the arms alternating in the puncture before and after in order to prevent the sample from hurting the same piercing mark. Each blood sample was collected 2 times before exercise and immediately after exercise. Half the life of IGF-1 was approximately 10-20 minutes. Blood samples were collected in total of 3-4 milliliters at a time, for a total of 15 milliliters. After placing the blood in a vacuum tube (VACUETTE, Greiner Bio-One, Chonburi, Thailand) and set aside for 30 minutes at room temperature (20-25 degrees Celsius), took the blood sample was taken to spin with a centrifuge (NF 400R, Nüve, Ankara, Turkey) at a speed of 3,000 rpm at 4 degrees Celsius for 10 minutes. Then, serum was separated and stored in a cooling cabinet (BIOBASE, Biobase Biodustry, Shandong, China) at a temperature of minus 20 degrees Celsius, for while waiting for the analysis of the concentration of IGF-1 in serum by means of Enzyme-linked immunosorbent assay (ELISA) (R&D Systems, Minneapolis, Minnesota, United States of America)

Data analysis

Data analyses of the differences between and within groups were performed using SPSS version 21.0 for Windows (SPSS, Inc, Chicago, IL) software. The results from the measurements were provided with means and standard deviations. Normality test for the data had been performed using Shapiro-Wilk Test. Independent samples *t*-tests were conducted to compare participants' demographic and physiologic characteristics. To assess the effects of body weight, sex and time on serum GH concentrations, a series of 2 (boys or girls) x 2 (pretest or posttest) x 2 (normal-weight or obese) fixed model ANOVA with repeated measurements were used. Significant interaction effects were followed up with independent samples *t*-tests and dependent (paired) samples t-tests. The level of significance for all statistical analyses was set at $\alpha < .05$.

RESULTS

Participant characteristics were presented in table 1 for means and standard deviations. There were no significant differences between groups on age, height, and resting heart rate ($p > 0.05$). However, obese children (boys and girls) had a higher body weight than normal-weight children ($p < 0.05$). Obese girls had a higher SPB than normal-weight girls ($p < 0.05$). Obese boys had a higher DBP than normal-weight boys ($p < 0.05$). Mean and standard deviation for growth hormone secretion of boys and girls with normal-weight and obese at pretest and posttest were presented in table 2.

Table 1. Participant characteristics presented as mean (M) and standard deviation (SD)

Variables	NW boys)N=14)		Obese boys (N=13)		NW girls (N=15)		Obese girls (N=9)	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Age (y)	11.27	0.54	11.28	0.55	11.29	0.53	11.29	0.54
Weight (kg.)	40.86	5.26	57.64	12.87	43.47	5.15	58.0	10.19
Height (cm.)	147.79	7.05	150.04	8.26	151.60	5.06	153.12	6.83
SPB (mm Hg)	102.57	9.33	110.73	11.28	108.00	14.72	126.37	5.07
DSB (mm Hg)	60.85	7.15	72.36	13.31	66.33	11.39	73.75	7.40
RHR (bpm)	90.64	19.55	98.36	10.77	93.73	13.94	93.75	17.72

Table 2. Growth hormone secretions (ug/L)

Sex	Body weight	Pretest		Posttest	
		Mean	S.D.	Mean	S.D.
Boys	Obese	0.89	0.96	0.69	1.14
	Normal weight	1.37	1.99	3.42	3.35
	Total	1.16	1.61	2.22	2.92
Girls	Obese	2.78	1.47	0.95	1.81
	Normal weight	3.60	2.85	5.61	4.96
	Total	3.32	2.46	3.99	4.67
Total	Obese	1.69	1.51	0.80	1.42
	Normal weight	2.53	2.68	4.55	4.33
	Total	2.19	2.31	3.07	3.92

ANOVA tests showed that there was no time by sex by body weight interaction, time by sex interaction,

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and sex by body weight interaction (all, p > 0.05); but there was a significant time by body weight interaction ($p < 0.05$, ηp2 = .15). Statistics presented a significant main effects of sex and body weight effects (all, $p < 0.05$, ηp2 = .127 and ηp2 = 0.203, respectively) with girls having a higher serum GH concentrations than boys (see Fig.1A) and normal-weight children having a higher serum GH concentrations than obese children (see Fig. 1B).

Independent samples t-test showed that the serum GH concentrations value were not significantly different at PRE between normal-weight and obese children (boys and girls) ($p > 0.05$), but at POST, normal-weight children showed higher serum GH concentrations than obese children ($p < 0.05$; see Fig. 1B). Paired sample t-test revealed that obese children's serum GH concentrations at PRE were significantly lower than POST ($p < 0.05$; see Fig. 1B). In contrast, normal-weight boys and girls had significantly serum GH concentrations at POST which exceeded PRE ($p < 0.05$; see Fig. 1B).

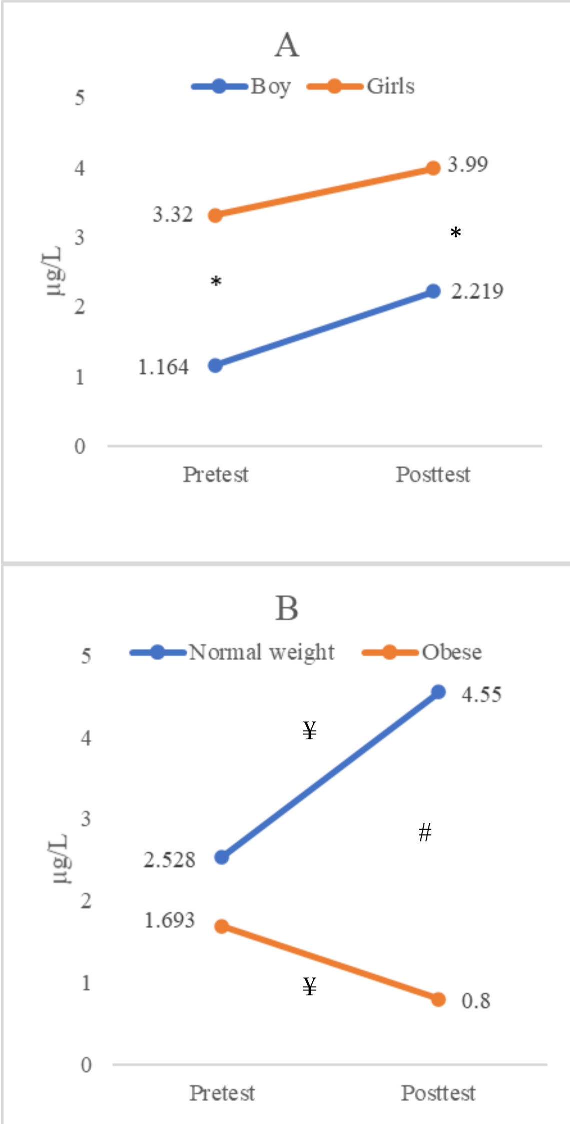

Figure 1. Serum GH concentrations between boys and girls (A), and between normal-weight and obese children (B) at pretest and posttest. * difference between boys and girls, # difference between normal-weight and obese children, ¥ difference between pretest and posttest.

DISCUSSION

This study showed that girls (both normal weight and obese) had a higher serum GH concentrations than boys at pre-exercise and post-exercise. There were no differences between normal weight (both boys and girls) and obese groups at pre-test. However, at a post-test, normal weight (boys and girls) had a higher serum GH concentrations than obese groups. Moreover, normal-weight groups presented a higher

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post-exercise serum GH concentrations than pre-exercise. In contrast, obese groups presented a lower post-exercise serum GH concentrations than pre-exercise.

The finding of sex difference in this study was similar to previous studies which found that women had a higher serum GH concentrations than men at rest (Giustina & Veldhuis, 1998; Wideman et al., 1999). This was similar to our finding that girls, both normal weight and obese, had a higher serum GH concentrations than a boy at pre-exercise. Also, previous studies presented sex differences in the GH response to exercise (Pritzlaff-Roy et al., 2002; Wideman et al., 2000; Wideman et al., 1999). Both women and men had a similar pattern of GH response to exercise (Pritzlaff-Roy et al., 2002; Wideman et al., 2000) and could attain more increases in serum GH concentrations during exercise; but the increase from baseline was significantly higher for men than women (Wideman et al., 2000). This supported our findings that at post-exercise, girls and boys showed no difference in serum GH concentrations. This was not a significant difference because boys increased more serum GH concentrations than girls from kangaroo exercise (91.4% vs. 20.2%, for boys and girls, respectively).

Furthermore, we found that at a post-test, normal weight (boys and girls) had a higher serum GH concentrations than obese groups. Previous studies had shown that obesity reduces the GH response to exercise (Hansen et al., 2012; Johannsson et al., 1997; Kanaley et al., 1999; Trabert et al., 2012; Veldhuis et al., 1995; Weltman et al., 2008). Paltoglou and colleagues found that obese boys presented lower GH concentrations than normal-weight boys after an acute bout of aerobic exercise (Paltoglou et al., 2015). This was confirmed by our finding, which found that normal-weight boys and girls had a higher post-exercise serum GH concentrations than pre-exercise; in contrast, obese groups presented a lower post-exercise serum GH concentrations than pre-exercise. However, previous studies normally found that exercise could increase serum GH concentrations in the obese population (Paltoglou et al., 2015; Rubin et al., 2015).

CONCLUSIONS

Kangaroo exercise can increase serum GH concentrations in normal-weight children, but in obese children, acute GH response to kangaroo exercise is impaired. The obese children presented diminished acute GH response to kangaroo exercise.

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