Associations of Different Appetite Hormones with Physical Activity and Cardiorespiratory Fitness in Adolescent Boys with Different BMI Values

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Background

Higher physical activity (PA) attenuates the health risks of obesity and is associated with better cardiorespiratory fitness (CReF). Different appetite hormones have been related to the different health risks of obesity. Acylated ghrelin is affecting appetite, food-intake and energy balance whereas des-acyl ghrelin is associated with adipogenesis.

Aim

To examine the associations of acylated and des-acyl ghrelin,peptide-Y (PYY) and leptin with different PA and CReF parameters in adolescent overweight (OWB) and normal weight (NWB) boys.

Patients and methods

55 boys with BMI > 85th centile (OWB) and 154 boys with normal BMI (NWB) aged 12-16 years. 37 /55 were with BMI > 95. centile.

Pubertal stage: by self-assessment illustrated questionnaire

Body composition: Total body (TB) and truncal fat mass (FM), body fat % and lean body mass (FFM) were determined by DXA using DPX-IQ densitometer (Lunar Corporation, USA).

Physical activity (PA):

- Total PA was measured by 7-day accelerometry (counts/min)
- Moderate PA (MPA) and vigorous PA (VPA) were determed as a time spent above cut-off points of 2000 and 4000 counts/min respectively and expressed as minutes per day.
- Moderate-vigorous PA (MVPA) = MPA + VPA.
- Sedentary behaviour was determed as a time spent below 100 counts per minutes and expressed as minutes per day.

Cardiorespiratory fitness (CReF): determined by direct measurement of peak oxygen consumption VO_2peak (l/min) and calculated per kg body mass (VO_2peak/kg) using a stepwise incremental exercise test until volitional exhaustion on electrically braked bicycle ergometer (Corival V3, Lode, Netherlands).

Blood samples: obtained from antecubital vein after overnight fast between 08:00 h - 10:00 h. Serum was separated within 2 hours and then frozen at -80°C for further analysis for:

- Serum total ghrelin concentration by RIA (Linco Research, USA)
- Serum acylated and des-acylated ghrelin by ELISA (Bertin Pharma, France). All work was completed on ice.
- Serum PYY by ELISA (Millipore Corporation, USA).
- Serum leptin by RIA (Mediagnost GmbH, Germany).
- Testosterone and insulin by Immulite 2000 (DPC, USA).
- HOMA-IR: fasting insulin (mU/l) x fasting glucose (mmol/l)/22.5

Statistical analyses

- Variables not normally distributed were log-transformed.
- Two-tailed t-test was used to determine differences between groups.
- Partial correlation analysis controlled for BMI, age and Tanner stages.
- Stepwise multiple regression analysis to determine the variability of CReF and PA

Results

Clinical characteristics of subjects and the main results are shown in Table. Mean ± SD are shown. $p < 0.05$ *.

Group	Normal weight boys (n=154)	Overweight boys (n=55)
Age (yrs)	14.0±0.7	14.0±0.8
Body height (cm)	168.4±9.1	172.0±7.8*
Body mass (kg)	53.6±8.8	80.0±17.8*
BMI (kg/m^2)	18.8±1.9	26.8±4.5*
Tanner stage (1|2|3|4|5)	4.08±0.78 (0|0|40|61|53)	4.13±0.74 (0|0|11|25|19)
Total body FM (kg)	8.1±3.4	25.8±12.3*
Total body FFM (kg)	42.9±8.0	50.0±9.8*
Trunk FM (kg)	3.1±1.4	11.3±5.6*
$VO_{2peak/l}$ (l/min)	2.7±0.6	3.1±0.5*
$VO_{2peak/kg}$ (ml/min kg)	50.5±6.8	39.7±8.7*
Sedentary behaviour (min/day)	569.7±95.1	564.6±89.6
Moderate PA (min/day)	36.6±15.0	41.2±16.3
Vigorous PA (min/day)	20.9±16.8	15.7±11.9*
Moderate-vigorous PA (min/day)	57.5±27.7	56.9±22.1
Total PA (counts/min)	410.5±170.0	394.9±141.7
Testosterone (nmol/l)	13.9±6.1	9.7±5.3*
Leptin (ng/ml)	2.0±2.7	11.6±10.6*
Insulin (mU/l)	11.0±6.2	18.1±8.7*
Glucose (mmol/l)	5.1±0.4	5.2±1.9
HOMA-IR	2.5±1.4	4.1±2.1*
Acylated ghrelin (pg/ml)	550.4±851.1	660.4±1124.5
Des-acyl ghrelin (pg/ml)	312.1±182.9	299.8±209.0
Peptide YY (pg/ml)	93.3±56.8	94.4±49.7

Leptin was negatively correlated with CReF in both groups (r=-0.43; p<0.05) and des-acyl ghrelin with CReF only in OWB (r =-0.36; p<0.05).

In OWB leptin was negatively correlated with total PA (r=-0.32; p<0.05) and positively with sedentary behaviour (r=0.35; p<0.05).

In NWB 28.1% of the variability of CReF was determined by leptin and HOMA-IR and in OWB 71.9% by trunk FM and BMI.

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Conclusions

- Leptin concentration is inversely associated with cardiorespiratory fitness in adolescent boys independently of BMI.
- High serum des-acyl ghrelin concentration in overweight boys was associated with low cardiorespiratory fitness.
- High serum leptin level in overweight boys is associated with low physical activity and with more time spent in sedentary behaviour.
- Longitudinal studies through puberty are needed to clarify the physiological interaction between different appetite hormones and cardiorespiratory fitness.

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