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## The one year exercise and lifestyle intervention program KLAKS: Effects on anthropometric parameters, cardiometabolic risk factors and glycemic control in childhood obesity

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### ABSTRACT

**Objective.** Regular physical exercise within structured lifestyle programs may improve weight status and minimize metabolic risk factors in childhood obesity. The aim of this study was to evaluate the effect of the one-year combined physical exercise/lifestyle program KLAKS on anthropometric and metabolic parameters and glycemic control in childhood obesity.

**Materials and Methods.** 142 overweight/obese (BMI > 90th percentile) candidates (7–18 years) were enrolled, 115 participants completed the program. Anthropometrics and biochemical parameters were obtained at beginning and completion. An oral glucose tolerance test (OGTT) was performed in a subgroup of participants. Course of glucose and insulin levels within OGTT was correlated with several parameters and is reported here for those who completed the program.

**Results.** The mean standard deviation scores (SDS) decreased significantly for BMI, waist circumference, waist-to-height ratio (WHR) and percentage body fat (all  $p \leq 0.01$ ). Improved metabolic risk markers included mean glucose levels within an OGTT at follow-up compared to baseline ( $p < 0.0001$ ) and HbA1c ( $p = 0.05$ ) as well as indications of improvement for gamma-glutamyl-transferase and free fatty acids.

**Abbreviations:** ALAT, alanine aminotransferase; ASAT, aspartate aminotransferase; BF, body fat; BMI, body mass index; FI, fasting insulin; GGT, gamma glutamyl transferase; HDL, high density lipoprotein cholesterol; HOMA-IR, homeostasis model assessment of insulin resistance; ITT, intend to treat; KLAKS, Concept Leipzig: Adiposity therapy for school aged children; LDL, low density lipoprotein cholesterol; OGTT, oral glucose tolerance test; PP, per protocol; SDS, standard deviation score; SE, standard error; UA, uric acid; WHtR, waist to height ratio; WHR, waist to hip ratio.

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**Conclusions.** The one-year combined exercise/lifestyle program KLAKS significantly improves markers of obesity and glycemic control. Impaired cardiometabolic risk markers, even subclinical, are also favorably influenced by program participation.

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## 1. Introduction

Childhood overweight and obesity are worldwide health problems [1]. Prevalence rates have reached very high levels during the past decades [2], although there seems to be a trend towards stabilization at a still alarmingly high level [3,4]. Many obese children and adolescents already present with features of the metabolic syndrome, including disturbed glucose metabolism, dyslipidaemia, elevated transaminases, non-alcoholic fatty liver disease and others [5–10]. Especially abdominal obesity, defined as increased waist circumference, is associated with increased risk for cardiometabolic comorbidities and the metabolic syndrome already in childhood [11,12]. Thus, early and effective treatment of childhood obesity and prevention of comorbidities are essential, and regular physical activity and the avoidance of sedentary habits play an important role not only for the stabilization or reduction of body weight but also for the avoidance of associated cardiometabolic comorbidities and for psychosocial well-being [13]. A recent guideline on prevention of type 2 diabetes in adults provides clear recommendations: Even a modest change in lifestyle that includes adopting a healthy diet, increasing physical activity and maintaining a healthy body weight, may effectively prevent the risk for diabetes later in life, and these results have since been the basis for worldwide prevention programs [14].

Current pediatric guidelines recommend at least 60, or preferably 90 and more minutes of physical activity per day, however, this amount is reached only by a small number of children [13]. The optimal therapeutic intervention to reduce (abdominal) obesity and cardiometabolic risk factors in childhood obesity is largely unknown, and available studies that have investigated the impact of different exercise regimens or the “optimal” exercise modality are scarce to date [15]. The aim of the present study is to evaluate the effects of the one year combined exercise/lifestyle intervention (KLAKS program) on anthropometric parameters and body composition, glycemic control and cardiometabolic risk markers in childhood obesity.

## 2. Materials and Methods

### 2.1. Participants

Children and adolescents aged 7–18 years with overweight (BMI > 90th percentile) and accompanying comorbidities (impaired glucose tolerance, features of the metabolic syndrome or a family history (siblings or parents) for obesity/type 2 diabetes) or obesity (BMI > 97th percentile) according to German reference percentiles [16] were eligible for program participation. In addition, overweight siblings of obese partic-

ipants were also invited to participate in the KLAKS program to facilitate lifestyle changes within the family. Written informed consent was obtained from all parents or guardians. The study protocol was approved by The Medical Review Board (see below). The entire study was conducted in accordance with the Declaration of Helsinki.

### 2.2. Intervention

The intervention program KLAKS (Concept Leipzig: adiposity therapy for school-aged children) is a therapy program for obese children and adolescents. The program has been certified and approved by the German Medical Review Board of the Statutory Health Insurance Funds as well as by the German Association of Childhood Obesity (AGA, [17]).

The one year lifestyle intervention is mainly based in increased physical activity (150 min/week) and consists of several modules:

- A total of 39 physical exercise sessions per intervention year (90 min/week of supervised exercise by certified trainers and an additional 60 min/week of independent free use of the sports facilities, tailored to three age groups
- Classes with diet counseling and on the preparation of healthy meals (60 min each), tailored to three age groups (14 per intervention year)
- Classes with psychological coaching/support (90 min each), tailored to three age groups (10 per intervention year)
- Classes on medical background of obesity (60 min each), tailored to three age groups (3 per intervention year)
- Classes for parents on diet counseling and preparation of healthy meals (60–90 min each, 7 per intervention year)
- Classes for parents on physical education and exercise (60–120 min each, 6 per intervention year)
- Parent–teacher conferences (7 per intervention year, 60 min each) [18].

The aim of the intervention is to prevent a further increase in BMI-SDS, to improve physical and mental well-being as well as to diminish metabolic and/or cardiovascular co-morbidities within one year of intervention.

### 2.3. Physical exercise

The physical exercise module within the KLAKS-program consists of a total of 90 mandatory and supervised minutes of physical training per week (see above). The entire exercise training is performed at a local sports center (Gesundheits-sportverein Leipzig e.V.). All exercise sessions are by appointment and are directly supervised and guided by licensed physical education instructors. An additional 60 min/week are performed according to the manual. The 39 physical

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