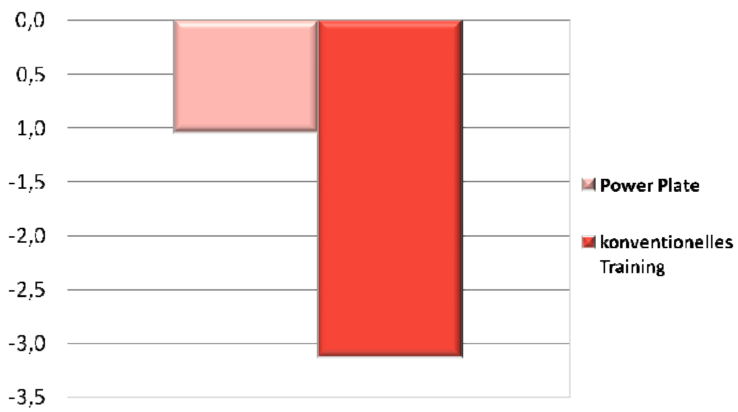
Die Power Plate im therapeutischen Einsatz bei adipösen Kindern und Jugendlichen.

Radtke T. et al., Alpine Kinderklinik Davos, Schweiz (2008).

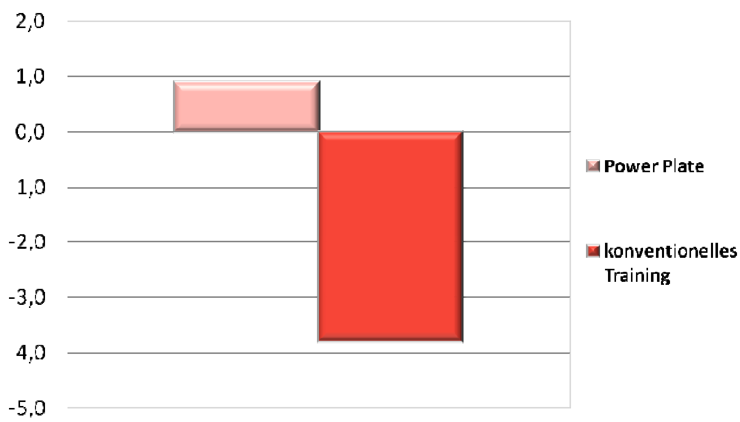
Ziel der Studie:	Untersuchung ob ein Beschleunigungstraining auf der Power Plate eine therapeutische Maßnahme bei der Behandlung von Adipositas bei Kindern und Jugendlichen darstellt und dem mit einer Gewichtsreduktion verbundenen Abbau der Muskulatur entgegenwirkt.
Dauer:	8 Wochen
Gerät:	Power Plate Pro 5 Air
Probanden:	90 übergewichtige Kinder und Jugendliche (33 Mädchen, 57 Jungen) im Alter von 10 – 17 Jahren.
Gruppen:	Power Plate-Gruppe (PP): 3-mal wöchentlich in Kombination mit Ausdauertraining. Dauer der Power Plate Einheit ca. 15 Minuten. Konventionelle Trainings-Gruppe (KKT): 3-mal wöchentliches intensives Training mit zusätzlicher Pädagogikeinheit.
Parameter:	Bestimmung der Fettarmen Körpermaße mittels Röntgenuntersuchungen (x-ray).

Ergebnisse: **90 übergewichtige Jugendliche (33 Mädchen und 57 Jungen) mit einem Durchschnittsalter von 14.3 Jahren und einem mittleren BMI von 33.5 kg/m2 wurden in dieser Studie untersucht. Der Verlust der Muskulatur während der Gewichtsreduktionsperiode war in der PP-Gruppe deutlich geringer (-3.13 vs. -1.04%; p=0.034) und vor allem bei den älteren (14-17 Jahre) männlichen Probanden beobachtbar. Hier konnten sogar Zunahmen der fettfreien Körpermaße (u.a. Muskulatur) beobachtet werden (0.9% vs. -3.8%; p=0.006). Es konnten keine Unterschiede bei den weiblichen Probanden beobachtet werden.**



Durchschnittlicher Verlust der Muskulatur (fettfreien Körpermaße) während des Gewichtsreduktionsprogramms in Prozent [%]

Fazit: **Die Anwendung der Power Plate während eines Gewichtsreduktionsprogramms verhinderte den Verlust der fettfreien Körpermaße (u.a. Muskulatur) vor allem bei männlichen Probanden im Alter ab 14 Jahren, wogegen jüngere Kinder und weibliche Teilnehmer keine deutlichen Effekte zeigten. Ein besserer Trainingszustand und hormonelle Einflussfaktoren können mögliche Gründe für diese Beobachtungen sein. Die Power Plate Anwendung stellt demnach eine Möglichkeit dar, dem Verlust der Muskulatur bei einem Gewichtsreduktionsprogramm bei männlichen Jugendlichen entgegen zu wirken.**



Durchschnittlicher Verlust der Muskulatur (fettfreien Körpermaße) während des Gewichtsreduktionsprogramms bei den männlichen Probanden (14-17 Jahre) in Prozent [%]

Whole body vibration decreases loss of muscle mass during an inpatient weight reduction program in male obese adolescents

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Abstract

Objective: Loss of muscle mass is a frequent observation in inpatient weight reduction programs. The aim of this study was to evaluate the effects of whole body vibration (WBV) on body composition in severely obese adolescents during a multidisciplinary inpatient weight reduction program consisting of daily physical activity, a balanced nutrition regimen and behaviour modification.

Methods: Subjects between 10 and 17 years of age with primary obesity and a BMI >98 percentile were included. Lean body mass (LBM) was measured before and after the eight-weeks intervention using dual energy x-ray absorption. Patients were randomized to receive either daily supervised exercise training including WBV (Powerplate®) three times per week or exercise training and educational sessions without physical activity instead.

Results: 90 severely obese adolescents (33 girls and 57 boys) with a median (25^{th}, 75^{th} percentile) age of 14.3 years (12.3, 15.8) and a median BMI of 33.5 kg/m^2 (30.6, 37.3) were analyzed. The loss of LBM was significantly lower in subjects receiving WBV training (-3.13 vs. -1.04%; p=0.034). This effect was reproducible in boys (p=0.020), however there was no difference in loss of LBM for girls. Stratification into early (10-13 yrs) and middle (14-17 yrs) adolescence demonstrated that older subjects benefited from WBV training (p=0.002) unlike younger individuals. Accordingly, older boys even increased their LBM when using WBV training compared to individuals without WBV (0.9% vs. -3.8%; p=0.006), whereas all other subgroups showed no significant difference.

Conclusion: WBV training demonstrated beneficial effects on loss of muscle mass in a multidisciplinary inpatient weight reduction program in severely obese male adolescents older than 14 years, whereas girls and younger boys did not improve significantly from the WBV intervention. General better trainability in males and hormonal status are presumable key factors for this observation. In conclusion, WBV training should be considered in male adolescents over 14 years of age for preventing loss of muscle mass in the context of weight reduction programs.

Ethics Commission Amendment to original study:

EFFECT OF COLD CLIMATE ON RESPONSE
OF OBESE CHILDREN TO A REHABILITIATION PROGRAM
AT THE ALPINE KINDERKLINIK DAVOS

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Additional treatments and measurements:

1. Increase in Dietary Protein
2. Resistance Training using Power Plate
3. Measurement of Anaerobic Fitness with the Wingate test

Background & Rationale

Most research on the benefits of enhanced physical activity has focused on aerobic-type exercise (4; 5; 7; 10; 12; 13; 24; 26; 27; 29). Less data is available on the benefits that may be derived from resistance training (RT) (11; 17; 21; 28; 30; 31).

One of the stated benefits of RT is the maintenance, or even increase, in fat-free mass -- particularly if the patients are concurrently following a low-calorie diet (18; 26; 29)   These findings, however, have not been the subject of enough focus, despite a decline in lean body mass being reported in children and youth who are subjected to a low-calorie diet (6).

The addition of RT to the physical activity component of the inpatient treatment program will focus on the potential benefits of RT in relation to maintenance and possibly the gain of lean body mass (LBM), as overall body mass (BM) and body fat (BF) declines during the 8 week multidisciplinary inpatient treatment program of obese girls and boys, within the Alpine Children's Hospital Davos. While being an inpatient is not a normal environment for an otherwise healthy young person, this environment allows for a stricter control of the subjects' food intake and other physical activities, as well as for a standardized educational message.

Maintenance of LBM during the inpatient program has a critical influence on the long term outcome of weight reduction. Lean body mass has been described as the most significant determinant of resting energy expenditure (25). Persons with high resting energy expenditure (REE) utilise more energy and put on less weight in long term development (22). Another important component of maintaining lean body mass is the proportion of dietary protein the patients receive. Recent studies and a meta-analysis investigating the effect of altering dietary protein and carbohydrate proportions, supports the positive effect of a lower carbohydrate-increased protein diet on the loss of body mass and it's additional effect on body composition, corresponding to both a decrease in body fat and retention of LBM (18, 19). In addition increasing the proportion of dietary protein as a % of total macronutrient intake up to 25% has been shown to provide a greater degree of satiety, corresponding to a possible voluntary control of total daily energy intake (2, 15, 20). Previously, the protein content of the 'weight reduction dietary plan' was calculated as a percentage of total calories ingested, approximately 18% of the total energy intake.

Nutrition.

Energy intake includes a defined diet (see below) and approx. 300 kcal/week as snacks. The diet is determined according to each patient's initial body weight, as follows:

BODY WEIGHT CATEGORY, kg	**ENERGY INTAKE, kcal/24 hours**
> 80	1600
50 – 80	1400
<50	1300

Until now the macronutrient composition, in all weight categories:

Carbohydrate = 50-55% of energy intake; Fat = 25-30%; Protein = 18%.

This would correspond to a protein intake (in grams) of between 56-69gms per day depending on which one of the three energy levels the patient is assigned to. However, as has been realised, the majority of the patients are over 80kg's and many are over 100kg's. Therefore the proportion of dietary protein in grams per

Gender	Age	P-plate or Control	Weight IN	Weight OUT	Tot Wt Loss (kg)	% T-Bdy Wt Loss	% Fat IN	% Fat OUT	Tot % Fat Loss	%LBM IN	% LBM OUT	Δ in % LBM
male	13	C	87.1	74.2	12.9	14.8	47.4	44.2	3.2	46.1	44.0	2.1% Loss
male	12	C	123.6	103.4	20.2	16.3	47.2	43.6	3.6	64.4	61.1	3.3% Loss
male	12	P	98.6	80.7	17.9	18.2	51.3	46.1	5.2	48.3	47.8	0.5% Loss
male	16	P	108.5	86.4	22.1	20.4	43.4	31.5	11.9	61.5	62.9	1.4% Gain

As is shown, the two males who were randomized to the ‘Power-Plate’ group lost a greater percentage **(%) of Body Fat** compared to the two controls, and they also not only **lost a lower % of Lean Body Mass** (LBM) than the controls, but one participant using power plate managed to **gain 1.4% Lean Body Mass** following the 8 week inpatient multidisciplinary intervention program. This is contrary to the data on LBM before the addition of Resistance Training using Power Plate. In addition, the two participants using the Power- Plate **lost a greater percentage of Total Body Weight** over the 8 week program.

kilogram of body weight (g/kg) is actually quite low, i.e. often less than 1.0g/kg and sometimes as low 0.55g/kg. In relation to the goal of minimising the loss of lean body mass, protein intake should be increased across all three calorie levels: 70g of protein per day for a body weight less than 50kg's; 80g of protein per day for a body weight of 50-80kg's and 100g of protein per day for a body weight of 80kg's and greater. This would ensure that the majority of patients are receiving at least 1.0 g/kg of protein per day, which is the recommended dietary intake (RDI) of protein for children and adolescents (1).

Training using Power Plate:

During the 8 week multidisciplinary inpatient treatment program for obese children and adolescents, resistance training or placebo activity will be added to the normal treatment program of the AKD. To warm up 5 minutes of standardized activity will be performed. Using Power Plate (Swiss made generation, type PP NG CH) the most important muscle groups for daily activity will be trained. Power Plate produces a vibration which transfers energy from a platform to the muscles, resulting in 30 to 50 rapid and intense muscle contractions per second. The stimulus depends on the exercise type, the exercise duration, the frequency and amplitude of vibration, as well as the exercise repletion. Such training is able to induce an improvement in muscle strength (8; 9; 23). Table 1 describes the standardized protocol of the resistance training. During 8 weeks exercises, intensity, duration, amplitude and frequency will be increased. 5 exercises will train abdominal, pectoral, dorsal, scapular, and femoral muscle groups. To avoid absorption of the energy, exercises will be performed without shoes. For each patient an individual exercise position will be adapted (same angles position) and kept constant through out the whole training program.

Table 1

weeks	1	2	3	4	5	6	7	8
exercise types (no)	5	5	5	5	5	5	5	5
trainings per week (Tr/w)	2	3	3	3	3	3	3	3
numbers of sets (/Tr)	2	2	2	2	2	2	2	2
duration of exercise (min)	30	45	45	45	45	45	45	45
intensity by amplitude (low=2mm; high=4mm)	low	low	low	low	low	high	high	high
intensity by frequency (Hz)	30	30	35	40	50	30	35	40
Rest in between exercises (min)	15	15	15	15	15	15	15	15

Physical fitness. Prior to the intervention and after 8 weeks of resistance training, a Wingate test will be performed on a electronically braked cycle ergometer (type Excalibur Sport) to measure anaerobic performance (3; 14; 16; 32). After a standardized warm up of 5 minutes with an intensity of 1Watt/kg body weight the patients will pedal at maximal speed against a high constant resistance for 20s. To familiarize with the test, a 6s modified Wingate test will be performed before starting the 20s standardized test. To adjust the optimal resistance, the torque will be adapted according to body weight as shown in table 2. However this resistance will not be readjusted downwards as the patient's body weight decreases, as they are actually gaining strength with the daily prescribed exercise program. Power output and pedaling velocity will be measured with special resistive wire strains, fixed on the wheel and the pedals. For further analyses peak power, mean power, percentage of fatigue as well as time when peak power is reached will be determined.

Table 2.

age (years)	**load males**	**load females**
7-14	0.55*body weight	0.53*body weight
15-18	0.7*body weight	0.67*body weight

At the beginning and the end of each training session, ratings of perceived exertion will be determined by a Borg Scale. To monitor aerobic power VO_2max (at start and the end of the intervention with Jaeger® Oxycon Alpha, Version 4.5) and physical working capacity ($PWC_{170/150}$ 5 times per week) will be assessed on electronically braked cycle ergometers (Ergoline® ergo-metrics 900 and Ergo Fit MED 3000, respectively; heart rate by Polar® S610i).

Peak power and total work (or mean power) are both considered fitness indices. Peak power represents the explosiveness of the muscle group tested, whereas total work and mean power are taken as indices of muscle endurance. Although % fatigue has not been linked to a specific fitness characteristic, it is strongly associated with the predominance of fast-twitch muscle fibers in the vastus lateralis muscle (3).

Objectives

The **main objectives** of these alterations in study design are to:

- Observe the effects of RT as an addition to the standard physical activity component of the multidisciplinary obesity treatment program within AKD

- More appropriately meet the nutritional needs of the obese paediatric patient undergoing weight loss
- Observe whether the increase in **dietary protein** slows or reverses the loss of lean body mass during weight loss (retrospective comparison of AE only patients)
- Observe psych-emotional/motivational differences between those patients participating in additional **resistance training** and those participating in a **placebo activity** (school work). Both groups continue to participate in aerobic activity as part of the standard physical activity protocol.
- Assess, using the **Wingate Test** any change/ improvement in anaerobic muscle strength, as a result of RT
- Primary outcome variables will be as before, documented in the original study protocol.

Addition to original study design

The proposed study addition will be a randomized-controlled intervention, in which obese inpatients will be divided into two groups according to the exercise program that they will be given. One group will undergo an aerobic program (control group = CG) as currently designed for all obese inpatients at the AKD, while the other will undergo aerobic plus resistance training (RT) program (intervention group = IG). To account for a possible placebo effect of socializing through the RT program, the AE group will be given the opportunity to socialize in a non-exertional organized activity. All patients will be given a standardized diet and lifestyle education.

Allocation into the groups will be done randomly. The two groups (IG and CG) will be randomized by the age in days at the beginning of the intervention: date at the beginning of the intervention (first day in the AKD) minus birthday date in days. Odd numbers will join the resistance training group; even numbers the control group.

Subjects

All patients aged 10 to 20 years, with primary obesity, will be invited to participate in the study. From all patients, informed written consent will be obtained. A parent of each patient, irrespective of age, will also sign an informed consent. We shall exclude from the study only those patients who, for any reason, do not participate in the regular rehabilitation program. Based on previous training-obesity studies, we plan to recruit 100 patients.

MEASUREMENTS

All patients, irrespective of treatment group, will undergo the same measurements, which will take place at the start and at the end of the program. Several measurements will also be taken 6, 12, 24, and 36 months after the subjects return to their home environment.

In-Hospital testing. The following tests and measurements will take place during the first 2-3 days and last 2-3 days of hospitalization:

- Body height, weight and composition (fat and fat-free mass), using DEXA. The scan will also provide information about regional distribution of fat and fat-free mass.
- Waist circumference
- Wingate anaerobic test.
- Maximal aerobic power during cycling (including maximal O2 uptake – VO2max).
- Tanner pubertal stage: breast development for girls and pubic hair for boys.
- Blood tests for plasma total cholesterol, LDL, HDL, triglycerides, fasting insulin and glucose.
- Quality of life questionnaire, translated into German.
- Body image self assessment.

Follow-Up Testing. To determine adherence to the lifestyle changes that the patient experienced while in the hospital, as well as the long-range effects of the program, repeated testing will be conducted 6, 12, 24, and 36 months after discharge from the Alpine Kinderklinik Davos. For this purpose, each patient will be invited to the hospital for a two-day period during each of the above 4 times. All tests as described for the in-patient period, apart from accelerometry and heart rate monitoring, will be conducted in each visit.

FOLLOW-UP PROGRAM

Prior to his or her discharge from the hospital, each patient is advised on how to apply to the home environment lifestyle items experienced during hospitalization. In addition, they are assigned individual therapists in proximity to their home: a pediatrician, psychologist, exercise therapist and nutritionist. This is an extremely important component of the AKD overall rehabilitation concept. The frequency of these encounters is individualized, depending on the need for support of each patient.

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