Does Resistance Training Improve the Functional Capacity and Well Being of Very Young Anorexic Patients? A Randomized Controlled Trial

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Does Resistance Training Improve the Functional Capacity and Well Being of Very Young Anorexic Patients? A Randomized Controlled Trial

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Abstract

Purpose: We determined the effects of a 3-month low–moderate-intensity strength training program (2 sessions/week) on functional capacity, muscular strength, body composition, and quality of life (QOL) in 22 young (12–16 yrs) anorexic outpatients.

Methods: Patients were randomly assigned to a training or control group (n = 11 [10 females] each). Training sessions were of low intensity (loads for large muscle groups ranging between 20%–30% and 50%–60% of six repetitions maximum [6RM] at the end of the program). We measured functional capacity by the time up and go and the timed up and down stairs tests. Muscular strength was assessed by 6RM measures for seated bench and leg presses. We estimated percent body fat and muscle mass. We assessed patients’ QOL with the Short Form-36 items.

Results: The intervention was well tolerated and did not have any deleterious effect on patients’ health, and did not induce significant losses in their body mass. The only studied variable for which a significant interaction (group × time) effect was found (p = .009) was the 6RM seated lateral row test.

Conclusions: Low–moderate-intensity strength training does not seem to add major benefits to conventional psychotherapy and refeeding treatments in young anorexic patients. © 2010 Society for Adolescent Medicine. All rights reserved.

Keywords: Resistance training; Anorexia nervosa; Strength tests

Anorexia nervosa (AN) is a life-threatening complex psychiatric disorder that involves the “relentless pursuit of thinness”[1] by restricting energy intake while increasing energy expenditure with exercise[2]. Whether regular, supervised exercise can be incorporated into the therapeutic armamentarium against AN is a subject of current debate. Controversy arises from the fact that excessive exercise has been postulated as a causal factor of AN, and it can be associated with a poor evolution of the established disorder[3,4].

Earlier reports showed several exercise-related benefits in anorexic patients. A refeeding program allowing exercise practice was more acceptable to the patients with no differences in rate of weight gain compared with a more strict program[5]. Vandereycken et al[6] recommended the use of recreational, group activities such as yoga, Tai Chi, or dance to help patients improve their self image. A controlled trial including patients between the ages of 17 and 45 years did not show significant differences in quality of life (QOL)–related outcomes between a training and control group after a 3-month period of stretching, resistance, and...
aerobic exercises [7]. Tokomura et al [8] reported no adverse effects on weight, recovery of menstruation, or eating disorder recurrence in anorexic women after a 6- to 12-month aerobic cycle–ergometry program. Their intervention was well tolerated and contributed to reduce emotional stress in the patients.

One important, often under-recognized, health problem associated with AN is metabolic myopathy, which is likely secondary to severe protein malnutrition and is characterized by selective type-2 fiber atrophy and reduced levels of strength [9]. Thus, resistance training seems the most clinically appropriate type of exercise program for anorexic patients. In this type of training, muscles contract against an external resistance with the expectation of increases in strength, tone, mass, and/or endurance, for example, using barbells, elastic bands, weight training machines, or own body weight. Szabo and Green [10] showed that, compared with a nonexercising group, the changes in body composition observed in hospitalized anorexic women (mean age, 23 years) during a refeeding protocol were unaffected by an 8-week light resistance training program. The intervention induced significant increases in the knee extensors’ peak force of the exercisers compared with controls [11]. One benefit of resistance compared with aerobic training is that caloric expenditure is usually lower [12]. Another benefit is the greater effect on bone density [13]. A question of practical applicability that remains to be answered is whether the potential benefits of resistance training in anorexic patients result in improved functional capacity during muscle tasks of daily living (e.g., climbing stairs, standing up from the lying or sitting position). It would be also clinically useful to determine whether young anorexic patients (≤16 years) benefit from resistance training interventions. This would support the notion that resistance exercises have a therapeutic value even in the youngest populations. Recent research showed the benefits of resistance training interventions in pediatric cancer patients with myopathy associated with bone marrow transplantation [14]. Finally, it remains to be determined whether, in anorexic outpatients, an easily applicable program (e.g., two sessions/week after psychological therapy) is sufficient to induce health and functional benefits.

The purpose of this randomized controlled trial was to determine the effects of a 3-month resistance training program (two sessions/week) on the functional capacity, muscle strength, body composition, and QOL of young anorexic outpatients (≤16 years).

Methods

Participants

We obtained written informed consent from all participants and their parents. The research protocol was reviewed and approved by the Children’s Hospital Niño Jesús (Madrid, Spain). The present randomized control trial was performed between January and March 2007, following the guidelines of the Declaration of Helsinki, last modified in 2000. We registered the study in www.clinicaltrials.gov (ID: NCT00829946).

From the database of the Children’s Hospital Niño Jesús (Madrid, Spain), we contacted 35 Spanish (Caucasian) young outpatients of both genders with restrictive AN. They all met the following inclusion criteria: (i) diagnosis of restrictive AN [15] in the aforementioned hospital; (ii) age ≤16 years; (iii) undergoing intrahospital psychotherapy and dietary counseling (two visits/week) in this hospital; and (iv) body mass index (BMI) >14.0 kg/m² [16]. A total of 22 outpatients (20 female [Tanner stage II–IV], 2 male [Tanner stage IV]; age 12–16 years) agreed to participate in the study. They were randomly assigned with a block on gender and Tanner stage for females (II or III–V) to either a training or control group (n = 11 [10 females] each). The participant randomization assignment followed an allocation concealment process [17,18].

The mean age (standard deviation, range) in the training and control group was 14.7 (0.6, 14–16) years and 14.2 (1.2, 12–16) years. The number of girls in Tanner stages III and IV was 2 and 8 in the training group and 3 and 7 in the controls, respectively. Time elapsed since initial diagnosis was 42 (11) and 72 (31) days in the training and control group, respectively. The main anthropometric characteristics of the participants since the time of diagnosis are shown in Table 1.

Physical activity and dietary intake assessment

Participants in the nonexercise control group were required to maintain their level of physical activity (PA) during the study period. To ensure that the level of PA apart from training sessions was similar in the two groups, we assessed the PA levels in all participants during the intervention period (excluding training sessions) using a uniaxial accelerometer (Actigraph MTI, model GT1 M, Manufacturing Technology Inc., Fort Walton Beach, FL). Details on this methodology are provided elsewhere [19]. At least 7 days of recording (Monday–Sunday) with a minimum of 10-hour registration per day was set as an inclusion criterion. The time sampling interval (epoch) was set at 60 seconds. A measure of average PA intensity was expressed as the sum of recorded counts per epoch divided by total daily registered time (i.e., counts per minute [cpm]). The time engaged in low, light, moderate, and vigorous physical activity was calculated using two regression equations [20,21].

Table 1

<table>
<thead>
<tr>
<th>Anthropometric characteristics since diagnosis by group</th>
<th>Control (n = 11)</th>
<th>Training (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest weight since diagnosis (kg)</td>
<td>41.1 (4.4)</td>
<td>39.3 (9.1)</td>
</tr>
<tr>
<td>Lowest BMI since diagnosis (kg/m²)</td>
<td>15.5 (1.0)</td>
<td>14.7 (1.4)</td>
</tr>
<tr>
<td>Weight gain since diagnosis (kg)</td>
<td>+5.9 (3.2)</td>
<td>+8.4 (3.4)</td>
</tr>
<tr>
<td>BMI at the start of the study</td>
<td>18.2 (1.5)</td>
<td>18.7 (1.7)</td>
</tr>
</tbody>
</table>

Data are means (SD). BMI = body mass index.
All p > .1 for group comparisons.
vigorous, and very vigorous PA was calculated upon the cut-off limits published elsewhere [19,20].

We recorded calorie intake (kcal/kg/day) in all participants using 3-day food records at the start and end of the intervention period. Daily calorie intake was in the range of 2000–2500 kcal/day depending on patients’ weight. Energy intake consisted of ~55% carbohydrate, ~30% protein, and ~15% fat.

**Intervention**

Participants in the intervention group were enrolled in two training sessions per week for 12 weeks. Each session lasted 60–70 minutes and started at ~11:30 AM, after the intrahospital psychotherapy session. The program was individually supervised (one instructor for every three participants).

Each session started and ended with a low-intensity warm-up and cool-down period (10–15 minutes each), each consisting of stretching exercises involving all major muscle groups. The core portion of the session included 11 strength exercises engaging the major muscle groups, that is, bench press, shoulder press, leg extension, leg press, leg curl, abdominal crunch, low back extension, arm curl, elbow extension, seated row, and lateral pull-down. The participants performed one set of 10–15 repetitions until volitional fatigue (~20-s duration) per exercise, with resting periods (including stretching exercises) of 1–2 minutes [21]. The load was gradually increased as the strength of each child improved, that is, from 20%–30% of 6 repetition maximum (6RM) at the start of the program to 50%–60% of 6RM at the end. For each exercise, the load was increased from one session to the next one when the subjects could complete 15 repetitions. Participants also performed isometric contractions of large muscle groups (six sets of three repetitions each, 20–30-s duration per repetition) with their own body weight (for lower body exercises) or barbells (1–3 kg) for upper body.

All training sessions were performed in an intrahospital gymnasium (Children’s Hospital Niño Jesús of Madrid, Spain) that includes weight training machines that are specifically built for the body size of children and adolescents (Strive Inc, PA).

**Outcome measures**

**Anthropometry.** Standing height was measured to the nearest .1 cm with a clinical stadiometer (Asimed T2, Barcelona, Spain) while children were standing barefoot. Body mass was determined to the nearest .05 kg using a balance scale (Ano Sayol S.L., Barcelona, Spain) with the subject in their underwear. BMI was calculated as weight divided by height (kg/m²). Skinfold thickness was measured as a Harpenden caliper at triceps, abdominal, and suprailliac area at the left side of the body [22]. We estimated percentage body fat [23] and total muscle mass (kg). The latter was calculated following the equation developed by Lee et al [24]: Muscle mass (kg) = Height (m) × (0.00744 × CAG² + 0.00088 × CGT² + 0.00441 × CCG²) + 2.4 × gender – 0.048 × age (yrs) + 7.8, where CAG is corrected arm girth; CTG, corrected thigh girth; and CCG, corrected calf girth, and gender equals 1 for male and 0 for female. Limb girths were corrected for subcutaneous adipose tissue thickness as detailed elsewhere [24].

All anthropometric measurements were performed by the same experienced researcher.

**Muscular strength.** Muscular strength was assessed in the upper and lower body following a standardized strength testing protocol using the same variable resistance weight machines that were used in training sessions. Lower body strength was assessed with a 6RM seated bench press and with seated lateral row, and upper body strength was assessed with a 6RM seated leg-press [25]. We have previously used the same 6RM test in diseased children with very weak muscles because of the effects of pediatric cancer and chemotherapy [14,26]. The 6RM value was measured in kilograms and is described as the maximum strength capacity to perform six repetitions until momentary muscular exhaustion [25]. The testing protocol consisted of three warm-up sets at 50%, 70%, and 90% of the perceived 6RM separated by 1-minute resting periods [25]. A 2-minute rest period followed the last warm-up set after which a 6RM attempt was made at 100%–105% of perceived 6RM. The load was adjusted depending on the load needed to perform the last warm-up set at 90% of the perceived 6RM. If the first 6RM attempt was successful, the load was increased by 2.5%–5% and after 2-minute rest another 6RM attempt was made. If the second 6RM attempt was successful, a second testing session was scheduled after 24-hour rest period. If the first 6RM attempt was not successful, the load was decreased 2.5%–5% and after 2 minutes of rest another 6RM attempt was made. If the second 6RM attempt was successful, the weight used was considered the 6RM. If the second 6RM attempt was not successful, another testing session was scheduled after 24 hours of rest. Each subject was instructed to perform each exercise to momentary muscular exhaustion. The repetitions that were not performed with a full range of motion were not counted.

**Functional mobility.** To measure children’s functional mobility, we used the Time Up and Go (TUG) test of 3 and 10 m and the Timed Up and Down Stairs (TUDS) test [14,27]. Both types of tests are reliable and valid in healthy children and also in children with various diseases or disabilities [27,28]. The TUG 3-m and 10-m tests are measures of the time needed to stand up from a seated position in a chair, walk 3 and 10 m, respectively, turn around, return to the chair, and sit down. For the TUDS, we measured the time taken to ascend and descend 12 stairs [14,27]. All participants used a hand railing while ascending and descending the stairs to diminish the risk of falling.

Before the start of the study all subjects underwent a familiarization period in order to minimize the influence
of a possible learning effect on the muscular strength and functional tests (because of improvement of technique and coordination or diminishment of muscle inhibition). It consisted of two ～ 50-minute sessions per week for a total of 2 weeks. Each session was preceded by a warm-up and ended with a cool-down of the same activities and duration used during the training period of the study. Each familiarization session consisted of two to three sets of one to three repetitions of the exercises (seated bench press, seated lateral row, seated leg press) used to evaluate muscular strength and two to three repetitions of the tests used to evaluate functional mobility (TUG and TUDS tests). Test–retest assessments were preceded by a warm-up period including stretching exercises (～10 min). A high intraclass correlation coefficient (r ≥ .98; p < .001) between repeated tests was demonstrated for all of the tests.

Quality of life. We assessed patients’ QOL with the Spanish version of the Short Form-36 items, which is valid for assessing QOL in Spanish patients with eating disorders and other psychological comorbidities [29].

All participants performed the tests at the time points corresponding to (i) before and (ii) after the intervention period. Participants consumed their usual breakfast (fruit juice [～200 cm³] and bowl of cereals [～45 g] with milk [～200 cm³]) 3 hours before the test protocols described below. All participants were followed up throughout the entire study period and underwent the same pre- and poststudy evaluations. No participant moved from the control group to the intervention group or vice versa.

Data Analysis

We used a two-factor (group, time) analysis of variance with repeated measures to assess the training effects on the outcome variables (anthropometric variables, performance in functional capacity and strength tests, and QOL). For each variable we reported the value corresponding to the main group (between-subjects), time (within-subjects), and interaction (group × time) effects. In post hoc analyses, and to prevent type I error, we calculated only the p value for within-group differences when a significant interaction effect was present. With regard to potentially confounding variables (i.e., calorie intake and PA levels), we used the aforementioned analysis for comparing mean daily calorie intake between both groups at the start and end of the study, and we applied a Student unpaired t test to compare mean PA levels.

The level of significance was set to ≤ .05 and all data are expressed as mean (standard deviation).

Results

There were no protocol deviations from the study as planned. The final number of participants included as valid study participants, that is, with a 100% return for follow-up, was 11 in each group. Of the 11 participants in the intervention group, nine completed all the planned training sessions. We noted no major adverse effect or health problem in any study participant.

There were no differences in the mean levels of PA between both groups (Table 2). Likewise, the daily calorie intake was also similar at the start (51.0 [7.4] and 52.4 [7.2] kcal/kg/day in training and control groups, respectively) and at the end of study (52.4 [8.3] and 52.7 [7.5] kcal/kg/day in training and control groups, respectively) (p = .662 for group, p = .770 for time, and p = .320 for group × time interaction).

We observed no significant differences, between or within groups, in anthropometric variables (Table 3). Dynamic 6RM strength significantly improved with training for the seated lateral row test (p = .009 for the interaction effect) but no actual improvement solely attributable to the training intervention was noted in the remaining strength/functional tests (Table 4). As for QOL, we observed no significant interaction effect and hence no intervention-attributable improvement (Table 5).

All of the aforementioned results did not materially change when we excluded the boy from each group in the analyses.

Discussion

The main finding of our study is that a low–moderate-intensity resistance training program performed in a hospital setting does not induce overall significant gains in the functional capacity (included aerobic capacity) of very young (≤16 years) anorexic outpatients nor in their ability to cope with physical activities of daily living. An actual improvement attributable to the training intervention (i.e., with a significant interaction effect) was observed only for the seated lateral row test. Although it did not significantly improve patients’ QOL, the training intervention was well tolerated, and it did not have any deleterious effects on patients’ health and did not induce significant losses in their weight or BMI. Future research might determine whether programs of longer duration (>3 months), higher frequency (more than two sessions per week), or higher loads (>60% of 6RM) are necessary in young anorexic outpatients to.

<table>
<thead>
<tr>
<th>Physical activity levels by group (excluding training sessions)</th>
<th>Control (n = 11)</th>
<th>Training (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average intensity PA (cpm)</td>
<td>409.1 (95.1)</td>
<td>444.3 (124.6)</td>
</tr>
<tr>
<td>Low PA (min/day)</td>
<td>1231.1 (102.2)</td>
<td>1282.4 (57.2)</td>
</tr>
<tr>
<td>Light PA (min/day)</td>
<td>157.1 (94.1)</td>
<td>103.2 (36.1)</td>
</tr>
<tr>
<td>Moderate PA (min/day)</td>
<td>35.2 (23.9)</td>
<td>31.5 (35.8)</td>
</tr>
<tr>
<td>Vigorous PA (min/day)</td>
<td>11.4 (7.4)</td>
<td>17.7 (16.9)</td>
</tr>
<tr>
<td>Very vigorous PA (min/day)</td>
<td>4.7 (4.9)</td>
<td>5.4 (6)</td>
</tr>
</tbody>
</table>

Data are means (SD).

cpm = counts per minute; PA = physical activity.
All p > .1 for group comparisons.
induce major improvements in their functional capacity, muscular strength, and QOL. Nevertheless, it is noteworthy that more demanding programs might not be easily applicable in very young patients with AN.

Our findings on body composition were limited by the fact that we used estimation equations to estimate muscle and fat mass, yet this method might not be sensitive enough to detect small changes in muscle mass (≤ ±3% in this study). It is likely that the use of more advanced and accurate techniques to assess body composition such as underwater weighing, air displacement plethysmography, or dual-energy x-ray absorptiometry may help to better elucidate the effect of the intervention on these patients. Unfortunately, for practical reasons this option was not possible in the present study. The difference between groups in the mean time elapsed since diagnosis (42 and 72 months in the training and control group, respectively), might have influenced, at least partly, some of our results. However, it must be kept in mind that main outcome variables (such as anthropometric data or functional capacity) were similar in the two groups at the start of the intervention. On the other hand, there were several novelties and strong methodological aspects in our randomized controlled trial compared with previous pioneer research in the field using resistance training (also two weekly sessions) in older (>15 years) anorexic patients [10,11].

Our participants underwent a thorough familiarization period before performing the baseline functional and/or strength tests and performed a second test to assess testing reliability. A familiarization period to eliminate learning effects and assess the reliability of pretraining tests is necessary to accurately determine the effects solely attributable to training on muscular strength [30]. Otherwise, potential increases in muscle strength could be artificially inflated. Instead of measuring peak muscle force [11], we assessed the effects of exercise training on (i) functional tests of practical applicability, that is, reflecting the ability to perform lower-body functional living tasks involving rapid movements (TUG and TUDS tests), and (ii) submaximal strength (6RM).

Improvements in maximal dynamic strength would not be of great practical relevance for nonathletes and particularly in persons with disease conditions such as those studied here. Maximal strength is not a main determinant of a patient’s ability to perform daily physical activities, which are mostly submaximal strength tasks such as climbing stairs or sitting and rising from a chair.

Myopathy resulting from severe protein malnutrition and reduction of muscular strength is an important clinical problem in anorexic patients [9]. Thus, resistance (strength)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>p (Group effect)</th>
<th>p (Time effect)</th>
<th>p (Interaction effect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>Control</td>
<td>46.6 (5.5)</td>
<td>47.2 (5.3)</td>
<td>.805</td>
<td>.766</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>48.2 (8.8)</td>
<td>47.0 (8.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Control</td>
<td>18.2 (1.5)</td>
<td>18.3 (1.6)</td>
<td>.821</td>
<td>.424</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>18.7 (1.7)</td>
<td>18.2 (2.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle mass (kg)</td>
<td>Control</td>
<td>19.8 (3.0)</td>
<td>20.4 (3.0)</td>
<td>.635</td>
<td>.276</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>20.7 (4.7)</td>
<td>20.8 (3.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>Control</td>
<td>13.8 (2.6)</td>
<td>13.9 (2.4)</td>
<td>.692</td>
<td>.372</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>14.8 (2.9)</td>
<td>13.7 (3.3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are means (SD).

**BMI** = body mass index.

### Table 4

Effects of a 3-month resistance training program on functional capacity and muscular strength

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>p (Group effect)</th>
<th>p (Time effect)</th>
<th>p (Interaction effect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUDS test (s)</td>
<td>Control</td>
<td>6.5 (0.5)</td>
<td>6.0 (0.7)</td>
<td>.366</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>6.3 (0.6)</td>
<td>5.8 (0.4)</td>
<td>.196</td>
<td>.196</td>
</tr>
<tr>
<td>TUG 3 m (s)</td>
<td>Control</td>
<td>3.9 (0.3)</td>
<td>4.0 (0.4)</td>
<td>.040</td>
<td>.175</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>9.7 (0.8)</td>
<td>9.4 (0.8)</td>
<td>.907</td>
<td>.002</td>
</tr>
<tr>
<td>TUG test 10 m (s)</td>
<td>Control</td>
<td>9.0 (0.7)</td>
<td>8.9 (0.7)</td>
<td>.890</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>9.0 (0.7)</td>
<td>8.9 (0.7)</td>
<td>.890</td>
<td>.002</td>
</tr>
<tr>
<td>Muscular strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bench press (kg)</td>
<td>Control</td>
<td>46.0 (7.9)</td>
<td>52.2 (10.2)</td>
<td>.801</td>
<td>.104</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>49.3 (10.1)</td>
<td>52.0 (6.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg press (kg)</td>
<td>Control</td>
<td>94.1 (21.3)</td>
<td>103.4 (24.9)</td>
<td>.424</td>
<td>.033</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>99.3 (12.5)</td>
<td>111.6 (20.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seated row (kg)</td>
<td>Control</td>
<td>46.0 (11.8)</td>
<td>46.9 (11.3)</td>
<td>.239</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>45.4 (5.7)</td>
<td>59.0 (13.7)*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are means (SD).

**TUDS** = Timed Up and Down Stairs test; **TUG** = Timed Up and Go test.

* *p* = .002 for Pre vs. Post in the Training group (*p* = .854 within Controls).
training seems the most clinically appropriate type of exercise program for this population group. It is also of clinical interest to assess the efficacy of starting training interventions at the earliest possible stages of the disease, as we did in this study. Despite earlier concerns regarding the safety and efficacy of youth strength training, current public health objectives now aim to increase the number of children participating in this exercise mode, which has the potential to increase bone mineral density, motor performance skills, physical capacity, and overall health status in children and adolescents [21].

Although the program was well tolerated by participants, we did not observe significant intervention-induced strength improvements other than in lateral row. We previously found significant increases in all the functional and/or strength tests that we applied here in cancer survivors of a similar age range with myopathy induced by steroid treatment or graft-versus-host disease [14]. The difference between the present results and our previous findings with cancer patients [14] or those of previous research with adult anorexic patients [11] could be attributable to the poor physical status (very low muscle mass) and young age of our patients, which precluded the use of higher training loads.

Both training and control groups showed improvements in several QOL items during the study period. This finding is in agreement with previous research [10] and is likely due to the favorable psychotherapy effects in both groups. However, we did not find a significant interaction (group × time) effect reflecting an actual beneficial training effect on QOL. Thien et al [7] reported similar results in a controlled trial with older anorexic outpatients; they assessed QOL with the Short Form-36 questionnaire. In contrast, Szabo and Green [10] showed that, compared with a nonexercising group, the psychological well-being of adult hospitalized anorexic women improved after a light resistance training program.

Psychological well-being was nevertheless assessed with the Eating Disorder and Beck Depression Inventories. In summary, in young anorexic patients, strength training does not seem to add major benefits to conventional psychotherapy and refeeding treatments. It is nevertheless noteworthy that this intervention was well tolerated and did not have any deleterious effect on patients’ health, nor did it induce significant losses in their body weight and BMI. Future research might determine whether more intense programs are necessary to induce significant improvements in the muscle fitness and well-being of young anorexic outpatients.

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