

**Physical Activity Monitoring to predict Relapse in Patients with Anorexia Nervosa**  
(project no. 23-13)

**Authors**

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**Introduction**

Increased physical activity is often observed in patients with anorexia nervosa (AN) and has been linked with increased need of hospitalization, lower rates of weight gain, increased drop-out from treatment, as well as poor long-term prognosis. Altered physical activity in AN is thought to have multiple origins: e.g. the desire to burn calories and lose weight, to counteract weight gain during treatment, to stabilize mood and to prevent hypothermia. In some cases and illness phases, high level PA can show compulsive or addictive features. Additionally, starvation and hyperleptinemia have been linked with increased PA, both in rodent models (the “ABA”-model = activity based anorexia) as well as in clinical studies in AN patients. From an evolutionary perspective, increased PA in times of scarce energy supplies can be considered as food-searching behavior. PA behavior is complex and involves different dimensions, such as daily routine PA and exercise, and both voluntary and involuntary components, which are difficult to recall accurately. However, most studies rely on self-reported PA, and only few studies have objectively assessed PA in AN patients. The aims of our study were:

1. To objectively measure PA patterns both in adolescent and adult AN patients, and to compare these patterns with healthy volunteers.
2. To assess psychometric variables, body composition, food intake and leptin levels, in order to better understand the factors causing individual variability of PA.
3. Finally, the effect of PA patterns on short- and long-term weight trajectories was a parameter of interest.

**Methods**

The study was an observational cohort study in two units specialized in the treatment of eating disorders (Medizinische Klinik mit Schwerpunkt Psychosomatik and Klinik für Psychiatrie, Psychosomatik und Psychotherapie des Kindes- und Jugendalters, Charité-Universitätsmedizin Berlin, Germany). Patients diagnosed with AN were assessed on admission to inpatient treatment (“baseline”). There were three follow-up investigations: 4 weeks post discharge, as well as 6 and 12 months post discharge. To measure PA, a portable accelerometer (SenseWear™ PRO3; BodyMedia, Inc., Pittsburgh, PA, USA) was worn over three standardized consecutive days and data analyzed in combination with the

manufacturer's software (SenseWear™ Professional, Version 8.1, SMT medical technology, Würzburg, Germany). PA data included (i) steps/d; and (ii) time spent in different intensity levels:

- Sedentary behavior (SB), ranging from 1.1 to 1.8 MET points (e.g., light, seated activities)
- Light (LPA), ranging from 1.9 to 3 MET points (e.g., slow-paced walking, housework)
- Moderate (MPA), ranging from 3.1 to 5.9 MET points (e.g., bike riding, playing tennis)
- Vigorous (VPA), > 6 MET points (e.g., sprinting)

Food intake was assessed by 3 day food protocols (optidiet, GOE mbH, Linden, Germany), body composition by bioelectrical impedance analysis (BiaCorpus R, Medi-Cal Healthcare GmbH, Karlsruhe, Germany for adolescents, and Nutriguard-M, Data Input, Darmstadt, Germany for adults), and plasma leptin by commercial enzyme-linked immunosorbent assay. Psychometric tests included the following patient-reported outcome measures: Eating Disorder Examination Questionnaire (EDE-Q), Compulsive Exercise Test (CET), Exercise Dependence Scale, Obsessive-Compulsive Inventory - Revised (OCI-R), and the Symptom Checklist 27 (SCL-27). Additionally, healthy, normal weight matched volunteers were assessed in their ambulatory setting. The Charité-Universitätsmedizin ethical committee (Protocol Number EA2/034/14) approved the study.

## Results

We were able to include 47 adults (median age, 26 years; mean BMI 14.7 kg/m<sup>2</sup>) and 55 adolescents (median age 15 years; mean BMI 15.6 kg/m<sup>2</sup>) with AN into the study, for baseline assessments and to compare them with 30 healthy women and 20 healthy adolescent girls matched for age. Longitudinal data has so far been analyzed of 26 adolescent patients 4 weeks post discharge.

The following key findings could be derived from the study:

- (1) At baseline, high level PA (> 6 METS) with 0-2 min/d in AN patients was only of short duration and lower when compared with healthy controls (16 min/d). Both adults and adolescents with AN spent more time in low level physical activity (1.8-3 METs) when compared with healthy controls.
- (2) While high PA in AN is a commonly observed phenomenon by clinicians, accelerometry provides a valid and valuable tool to quantify PA, and to enable subgroup analyses of patients with different PA patterns. Only the subgroup with high low level PA at baseline decreased low level PA with weight gain, yet this subgroup continued to demonstrate increased low level PA 4 weeks post discharge when compared with healthy controls.
- (3) Leptin levels did not consistently show an association with the step count in adults with AN.

- (4) Some activity parameters (steps, light and moderate PA) showed a link with weight development over time; however this association was not strong. This suggests that other factors than PA patterns, such as baseline BMI and length of stay, have a higher effect on weight trajectories.
- (5) Opposed to our assumptions, cross-sectional analyses did not show a strong association between patient reported, eating disorder specific psychopathology. Instead, biological correlates, namely low body fat and low energy and fat intake, yielded a closer relation to PA patterns, such as low level PA. This suggests a biological regulation of PA alternations in AN
- (6) When comparing our findings to previous studies in the literature, we found that methods of PA assessment in patients with AN are were highly heterogeneous, and there is a large mix of concepts and terms to describe PA in AN.

### **Conclusion and outlook**

Our study contributes to a better understanding of altered PA in AN, pointing towards the importance of biological regulation of PA. With objective PA assessment, we were able to characterize PA patterns including time spent in different intensity levels more clearly than by assessing just the number of steps taken per day. Our study lead to a new hypothesis: a reduction of energy and fat intake might cause or sustain an increase in low level PA, and thus contribute to the onset and/or maintenance of AN. Future studies should assess food intake and PA longitudinally in outpatients with AN who are less restricted in their PA behavior and food choices. Targeted PA interventions might be a useful therapeutic add-on in order to support a normalization of PA patterns.

### **Research project offspring**

#### *Published articles:*

- (1) Stengel A, Haas V, Elbelt U, Correll CU, Rose M, Hofmann T: Leptin and Physical Activity in Adult Patients with Anorexia Nervosa: Failure to Demonstrate a Simple Linear Association. *Nutrients* 2017;Nov 3;9(11).
- (2) Haas V, Stengel A, Mähler A, Gerlach G, Lehmann C, Boschmann M, de Zwaan M, Herpertz S:
  - (1) Metabolic Barriers to Weight Gain in Patients With Anorexia Nervosa: A Young Adult Case Report. *Front Psychiatry*. 2018 May 18;9:199.
  - (2) Lehmann CS, Hofmann T, Elbelt U, Rose M, Correll CU, Stengel A, Haas V: The Role of Objectively Measured, Altered Physical Activity Patterns for Body Mass Index Change during Inpatient Treatment in Female Patients with Anorexia Nervosa.
- (3) *Journal of Clinical Medicine* 2018;Sep18;7(9).

#### *Articles in revision*

- (4) Haas V, Nadler J, Ehrlich S, Arnold S, Correll CU: Physical activity in patients with anorexia nervosa: systematic review of applied assessment methods in research studies.

*Submitted articles*

- (5) Großer J, Hofmann T, Stengel A, Zeeck A, Winter S, Correll CU, **Haas V**: Psychological and nutritional correlates of objectively assessed physical activity in patients with anorexia nervosa.
- (6) Kemmer M, Correll CU, Hofmann T, Stengel A, Grosser J, **Haas V**: Assessment of physical activity patterns in adolescent patients with anorexia nervosa and their effect on weight gain.

*Articles in preparation*

- (7) Pech M, Correll CU, Nadler J, Zeeck A, Haas V: The relation between patient self-reported pre-morbid and current physical activity for key clinical outcomes during inpatient treatment in adolescent patients with anorexia nervosa
- (8) Brückner F, Correll CU, Pech M, Grosser J, Kemmer M, Haas V: Physical activity and psychopathological factors in adolescent patients with anorexia nervosa.

*Oral conference presentations:* Annual meeting, Eating Disorder Research Society, Sydney 2018; Tagung, Deutsches Kollegium für Psychosomatische Medizin, Berlin 2018; Tagung, Deutsche Gesellschaft für Psychiatrie, Psychosomatik und Nervenheilkunde. Berlin 2018 & 2019;

The data obtained in the project is currently being used for a subsequent *grant application* on PA in AN.

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