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Physical self-concept and physical activity enjoyment of adolescents with esophageal atresia: a multicenter study

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Abstract

Background

Adolescents with esophageal atresia (EA) are significantly less physically active than their peers. Subjective physical self-concept (PSC) is one of the main drivers of physical activity (PA). The aim of this study was to explore PSC and PA enjoyment in these patients to design interventions accordingly.

Methods

A multicenter, cross-sectional study including adolescents aged 11–17 years with EA was conducted. PSC, enjoyment of physical activity, and PA were assessed using validated questionnaires for PSC (36–144 points), the Physical Activity Enjoyment Scale (PACES; 16–80 points), and the Motorik-Modul Physical Activity Questionnaire (MoMo-PAQ), respectively. Patients with congenital heart disease requiring interventional or surgical treatment were excluded. EA participants were matched 1:5 by age and sex with participants from the population-based Motorik-Modul (MoMo) study. Between-group comparisons and correlations between PSC, PACES, and PA were analyzed. Descriptive analysis, Mann–Whitney U test, and Spearman's correlation tests were performed as appropriate.

Results

Overall, 28 EA adolescent patients and matched 140 controls were included: 50% male, mean age 13.8y standard deviation (SD) 1.9, 82% Gross C, 18% minimally invasive repair, 43% preterm, 43% underweight. Symptoms during sports were present in 32%. No difference was detected in median overall PSC between EA patients and controls (104 vs 105 points, $p = 0.16$); however, scores in the subdomains of endurance and athleticism were significantly lower in EA patients. Among EA adolescents PSC was significantly lower in females, patients with lower body weight and height or symptoms during PA and patients aged 13-15y. Mean scores in the subscales of endurance and athleticism were significantly lower compared to controls. There was a significant association between PSC and PACES ($r = 0.71$, $p < 0.01$) and PA in EA (Spearman $r = 0.80$, $p < 0.05$) but not in controls (Spearman $r = 0.80$, $p = 0.35$).

Conclusions

While overall PSC was comparable to healthy peers, endurance and athleticism were significantly reduced in adolescents with EA. Female sex, underweight, symptoms during PA, and age 13–15 years were identified as risk factors. Lower PSC was associated with lower enjoyment of physical activity. Interventions to promote PA should therefore address both physical limitations and strategies to strengthen PSC.

Introduction

Esophageal atresia (EA) is a congenital malformation of the esophagus and airways that may result in lifelong complications, including gastroesophageal and respiratory morbidity (1, 2). In recent years, increasing attention has been directed toward the cardiopulmonary fitness and respiratory health of individuals with EA (2, 3). Previous studies have demonstrated that children and adolescents with EA engage in lower levels of overall physical activity (PA) and moderate-to-vigorous physical activity (MVPA) than their healthy peers (4, 5). Furthermore, impairments in cardiopulmonary fitness and physical performance have been reported, raising concerns about long-term health outcomes in this population (3, 6).

Regular PA is essential for healthy physical and psychological development and has been associated with improved well-being, fitness, and quality of life. Recognizing its importance, the World Health Organization recommends that all children and adolescents, including those with chronic diseases or disabilities, accumulate an average of 60 minutes of MVPA per day (7). Psychological factors such as physical self-concept (PSC) and enjoyment of PA play a crucial role in promoting an active lifestyle (8). A positive PSC is associated with greater resilience, motivation, and participation in PA, while enjoyment of movement increases the likelihood of maintaining regular exercise behavior (9, 10).

Despite the potential relevance of these factors, little is known about PSC and enjoyment of PA among children and adolescents with EA. Given the reduced levels of PA and physical fitness reported in this population, a better understanding of the psychosocial determinants of exercise behavior is needed. Therefore, the aim of this study was to explore PSC and enjoyment of PA in children and adolescents with EA. By identifying specific strengths and deficits in these domains, the study seeks to provide a foundation for the development of targeted interventions aimed at promoting PA and improving long-term health outcomes in this patient group. To compare the findings with other populations, outcomes were assessed against a population-based reference sample from the Motorik-Modul (MoMo) study (11, 12).

Methods

This multicenter, cross-sectional study enrolled children and adolescents with EA aged 11–17 years from four German pediatric surgery centers (Mainz, Mannheim, Bonn, and Munich) and the national EA patient organization KEKS e.V.

The study received a favorable vote from the local Ethics Committee of the State Medical Association of Rhineland-Palatinate (approval no. 2021–16048) and was registered in the German Clinical Trials Register (DRKS00025276) prior to the commencement of participant enrolment. Informed consent to participate was obtained electronically from the patients and legal guardians. All procedures were conducted in accordance with the Declaration of Helsinki. The patient cohort is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (13).

Data were collected using an online survey hosted on LimeSurvey (University Medical Center Mainz), comprising the validated Motorik-Modul Physical Activity Questionnaire (MoMo-PAQ) to assess moderate-to-vigorous physical activity (MVPA) in minutes per week, the Physical Self-Concept (PSC) scales, the Physical Activity Enjoyment Scale (PACES), and a standardized medical history questionnaire.

MVPA was assessed in minutes per week, including everyday activities such as walking or cycling for transportation and household activities. In addition to recording activity duration across different settings, participants reported the number of days per week on which they were physically active for at least 60 minutes. The number of activity days was calculated as the mean of the reported days with at least 60 minutes of physical activity during the previous seven days and during a typical week. The sports index was defined as the sum of sports activities per week in school, organized, or unorganized sports, not including everyday activity or active transportation.

The PSC questionnaire assesses six domains of physical competence: strength, endurance, flexibility, coordination, speed, and overall athleticism. Each domain was assessed using six items rated on a four-point Likert scale. The total score ranged from 36 to 144 points, with higher scores reflecting a more positive PSC. Enjoyment of physical activity was assessed using 16 items rated on a five-point Likert scale (1–5). After reverse-coding seven negatively worded items, item scores were summed (16–80), with higher scores indicating greater enjoyment of physical activity.

Eligible participants had a confirmed diagnosis of EA, were 11–17 years of age, and completed the questionnaire. Participants younger than 11 years of age, those with incomplete medical history data, or those with concomitant congenital heart disease requiring interventional or surgical treatment were excluded from the analysis.

For comparative analyses, EA patients were matched by age and sex (1:5) with participants from the population-based Motorik-Modul (MoMo) study (Schmidt et al., 2020). Continuous variables are presented as mean and standard deviation (SD) or median (interquartile range), and categorical variables as frequencies and percentages. Between-group comparisons were performed using the Mann–Whitney U test. Associations between continuous variables were assessed using Spearman's correlation. Statistical analyses were performed using IBM SPSS Statistics version 29.0.2.0, and a two-sided p value < 0.05 was considered statistically significant. For missing responses within the PSC questionnaire, subscale scores were calculated using the mean of the completed items.

Results

Study population

A total of 194 questionnaires were returned. After exclusion of incomplete responses and participants not meeting the predefined eligibility criteria, 28 adolescents with EA were included in the present subgroup analysis and matched 1:5 by age and sex with 140 participants from the population-based MoMo study (Fig. 1).

The EA cohort comprised 14 females and 14 males with a mean age of 13.8 SD1.9 years. Gross type C EA was present in 23/28 patients (82%). Seventeen patients (60.7%) had undergone open primary repair, while five (18%) had thoracoscopic repair. Sixteen patients (57%) had undergone fewer than six procedures under general anesthesia, whereas six (21%) had undergone more than 15 courses of general anesthesia. Gastrostomy was performed in six patients (21%), and fundoplication in four (14%). Twelve patients (43%) were born preterm and 12 (43%) were classified as underweight.

According to the International Obesity Task Force (IOTF) classification (14), 12 (43%) participants were classified as underweight and 15 as normal weight. One participant did not report their weight. The mean BMI-for-age z-score was − 0.81 SD 1.29 at four years of age (95% CI: −1.41 to − 0.20) and − 0.55 SD 1.33 at the current age (95% CI: −1.08 to − 0.02).

Overall, 14 patients (50%) reported current symptoms at rest, including gastroesophageal reflux in eight patients (29%) and respiratory symptoms in five patients (18%). During physical activity, nine patients (32%) experienced symptoms, with respiratory symptoms reported in eight patients (29%) and gastroesophageal reflux in two patients (7%). Thus, symptoms during physical activity were predominantly respiratory, whereas gastroesophageal reflux was more frequently reported at rest.

Physical self-concept, enjoyment of physical activity and physical activity

The median PSC score in the EA cohort was 104 points (range 61–136), while the median Physical Activity Enjoyment Scale (PACES) score was 46.5 points (range 33–53). Participants reported a median of 3 (range 0–7) physically active days per week and accumulated a median of 249.5 (range 0–1,868) minutes of MVPA per week. Overall PSC tended to be lower in females than in males, although this difference did not reach statistical significance (median 93 vs 106 points, $p = 0.25$); however, females scored significantly lower in the endurance domain ($p = 0.01$). PSC was positively correlated with PACES ($r = 0.71$, $p < 0.01$), MVPA (Spearman $r = 0.80$, $p < 0.05$), activity days ($r = 0.60$, $p < 0.01$), and sports index ($r = 0.57$, $p < 0.01$).

Disease-specific characteristics, including Gross type, thoracoscopic versus open repair, and primary versus delayed anastomosis, were not associated with overall PSC. Patients who had undergone fundoplication, however, demonstrated significantly lower PSC scores than those without fundoplication (median 79 vs 108, $p = 0.04$), particularly in the domains of general athleticism ($p = 0.02$) and strength ($p < 0.01$). Patients reporting symptoms during physical activity also had significantly lower PSC scores than those without symptoms (median 80 vs 108, $p = 0.01$), mainly attributable to lower endurance scores ($p < 0.01$). Symptoms during physical activity were predominantly respiratory (eight patients), while gastroesophageal reflux was reported by two participants. Lower body weight and height were associated with lower strength scores, whereas overall PSC was not significantly correlated with anthropometric measures. PACES scores were significantly lower among patients reporting symptoms during physical activity (9/28; median 37; IQR 33–52) compared with those without symptoms (19/28;

median 49; IQR 38–53, p = 0.01). Other than that, we detected no association with demographic, anthropometric, or disease-specific variables assessed in our study.

Comparison with healthy controls

Overall, PSC did not differ significantly between EA patients and matched healthy controls from the MoMo study (median 104 vs 105 points, p = 0.16). Likewise, PACES scores were comparable between groups (46.5 vs 44 points, p = 0.44). However, analysis of PSC subdomains demonstrated significantly lower scores for endurance (mean 2.33 vs 2.71, p = 0.04) and general athleticism (mean 2.65 vs 3.03, p = 0.02) in the EA cohort, whereas flexibility, coordination, strength, and speed were comparable between groups (Fig. 2). Despite similar PSC and PACES scores, EA patients reported significantly lower physical activity levels than healthy controls, including fewer physically active days (median 3 vs 4 days, p < 0.01) and lower weekly MVPA (median 249.5 vs 549.0 minutes, p < 0.01).

Correlation analyses

In the EA cohort, PSC demonstrated a strong positive association with physical activity, including weekly MVPA (Spearman r = 0.80, p < 0.05) and activity days (r = 0.60, p < 0.01), and was also strongly associated with enjoyment of physical activity (PACES; r = 0.71, p < 0.01). The correlation coefficients for all study groups are summarized in Fig. 3.

Discussion

To our knowledge, this study is the first to conduct a comprehensive assessment of physical self-concept and enjoyment of physical activity among adolescents with esophageal atresia. Although overall scores for PSC and enjoyment of physical activity were comparable to those of healthy peers, adolescents with EA perceived themselves as significantly less capable in areas such as endurance and athleticism. Furthermore, PSC was closely associated with overall physical activity, with the strongest correlation observed between PSC and weekly moderate-to-vigorous physical activity (MVPA). Female sex, symptoms during physical activity, and status past fundoplication were associated with a lower PSC score, whereas no differences were observed based on Gross classification or initial surgical approach.

The finding that overall PSC was comparable to that in healthy controls may appear unexpected given the reduced physical activity and impaired cardiopulmonary fitness consistently reported in children and adolescents with EA (5, 15). Rather than demonstrating a generalized impairment of self-perception, adolescents with EA reported deficits specifically in endurance and athleticism, while speed, coordination, and flexibility were comparable to those in healthy peers. Because endurance is closely linked to cardio-respiratory function, these findings are consistent with the well-described respiratory morbidity and reduced exercise capacity observed after EA repair (16). Notably, gastrointestinal symptoms appeared to play a subordinate role during physical activity. Thus, respiratory symptoms were

reported by eight patients (28.6%), compared with only two patients (7.1%) reporting gastroesophageal reflux. This suggests that respiratory symptoms may be more relevant than gastrointestinal symptoms in limiting physical activity and influencing perceived physical competence in adolescents with EA. However, these findings should be interpreted cautiously, given the small sample size. Larger studies are needed to determine how different symptom profiles and types of physical activity influence PSC and to guide the development of targeted exercise interventions.

One of the principal findings of this study was the strong association between PSC and physical activity in adolescents with EA. PSC correlated strongly with weekly MVPA and moderately with activity days and sports index. Although healthy controls also demonstrated significant associations between PSC and active days, no significant relationship was observed between PSC and MVPA, whereas this association was particularly strong in adolescents with EA. These findings suggest that perceived physical competence may be especially important for participation in higher-intensity physical activity among adolescents with EA. Although the cross-sectional design precludes conclusions regarding causality, lower PSC may discourage participation in physical activity, while reduced activity may in turn reinforce negative self-perceptions, creating a self-perpetuating cycle. This bidirectional relationship has been supported by longitudinal studies and systematic reviews in children and adolescents (8, 10).

Interestingly, adolescents who had undergone fundoplication reported significantly lower overall PSC, particularly in the domains of strength and general athleticism. Although only four patients had undergone fundoplication, this observation may reflect a subgroup with greater disease severity or persistent gastrointestinal and respiratory symptoms rather than an effect of the procedure itself. GERD remains a common long-term complication after EA repair, and recent evidence highlights the complexity of its management and the potential for persistent symptoms and complications following anti-reflux surgery (17). Thus, fundoplication may serve as a marker of greater clinical complexity rather than an independent determinant of physical self-concept. No significant associations were found with the Gross classification, surgical approach, or timing of repair; however, these findings also require confirmation in larger cohorts.

Furthermore, 43 percent of participants were underweighted even in adolescence, and lower body weight was associated with lower PSC. Nutritional impairment remains common in adolescents with EA owing to feeding difficulties, dysphagia, gastroesophageal reflux, and increased energy expenditure related to chronic respiratory disease (18). Although causality cannot be inferred, lower body weight may be accompanied by reduced muscle mass and energy reserves, therefore affecting physical performance. In this context, nutritional optimization should include satisfaction of additional energy demands associated with regular physical activity, particularly in underweight adolescents.

Female adolescents tended to report lower overall PSC than males, although this difference did not reach statistical significance. Endurance was the only PSC domain showing a significant gender difference, a pattern that was also observed among healthy controls. Previous studies have

demonstrated lower physical activity levels, particularly among girls with EA, suggesting that female adolescents may represent a vulnerable subgroup requiring targeted support (15, 19).

From a clinical perspective, the findings suggest that interventions to promote physical activity in adolescents with EA should address not only physical capacity but also the broader concept of physical literacy, which integrates physical competence with motivation, confidence, and knowledge to support lifelong engagement in physical activity. Given the association between PSC and habitual physical activity observed in this cohort, interventions could incorporate individualized goals, progressive skill development, and enjoyable movement experiences to strengthen perceived competence and sustained participation. Evidence from a systematic review and meta-analysis indicates that physical literacy interventions can positively influence physical competence, motivation, confidence, and physical activity behavior (20). Particular attention should be given to female adolescents and patients experiencing symptoms during exercise, who appear to represent groups at increased risk of low PSC.

This study has several limitations. First, its cross-sectional design precludes conclusions regarding causality between physical self-concept, physical activity enjoyment, and physical activity. Second, the sample size was relatively small owing to the rarity of EA and loss-to-follow-up in older patients, limiting statistical power for subgroup analyses, particularly those evaluating fundoplication or surgical approach. In addition, questionnaires were completed either independently by the adolescents or with parental assistance, which may have influenced the interpretation of individual items and the reported responses. Finally, although participants were recruited from multiple centers and a national patient organization, selection bias is possible, as families with greater interest in physical activity may have been more likely to participate. Furthermore, pulmonary function testing and objective exercise capacity measurements were not available for all participants, preventing assessment of how physiological impairment may contribute to physical self-concept and physical activity.

Conclusion

Adolescents with esophageal atresia demonstrated an overall physical self-concept comparable to healthy peers; however, perceived endurance and athletic competence were significantly reduced. Lower physical self-concept was associated with lower levels of physical activity, suggesting that psychosocial factors may contribute to the reduced activity levels previously reported in this population. Female sex, underweight status, and exercise-related symptoms were associated with lower physical self-concept, whereas anatomical characteristics and surgical variables showed no clear association. These findings indicate that interventions promoting physical activity in adolescents with esophageal atresia should address physical limitations and strengthen physical self-concept by emphasizing individual abilities and positive movement experiences. Larger prospective studies are needed to determine whether improving physical self-concept can lead to sustained increases in physical activity and better long-term health outcomes.

Abbreviations

EA
esophageal atresia
PSC
physical self–concept
PA
physical activity
PACES
Physical Activity Enjoyment Scale
MoMo
Motorik–Modul
MoMo
PAQ–Motorik–Modul Physical Activity Questionnaire
MVPA
moderate–to–vigorous physical activity
IOTF
International Obesity Task Force

Declarations

Ethics approval and consent to participate

Ethics approval is reported in Methods part of the Manscuript

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

TTK and CN contributed to the study conception and design. Data collection was performed by all authors. LMF, CN and TTK prepared material, analyzed and interpreted the patient data. AS analyzed the patient data and was major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Not applicable

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Figures

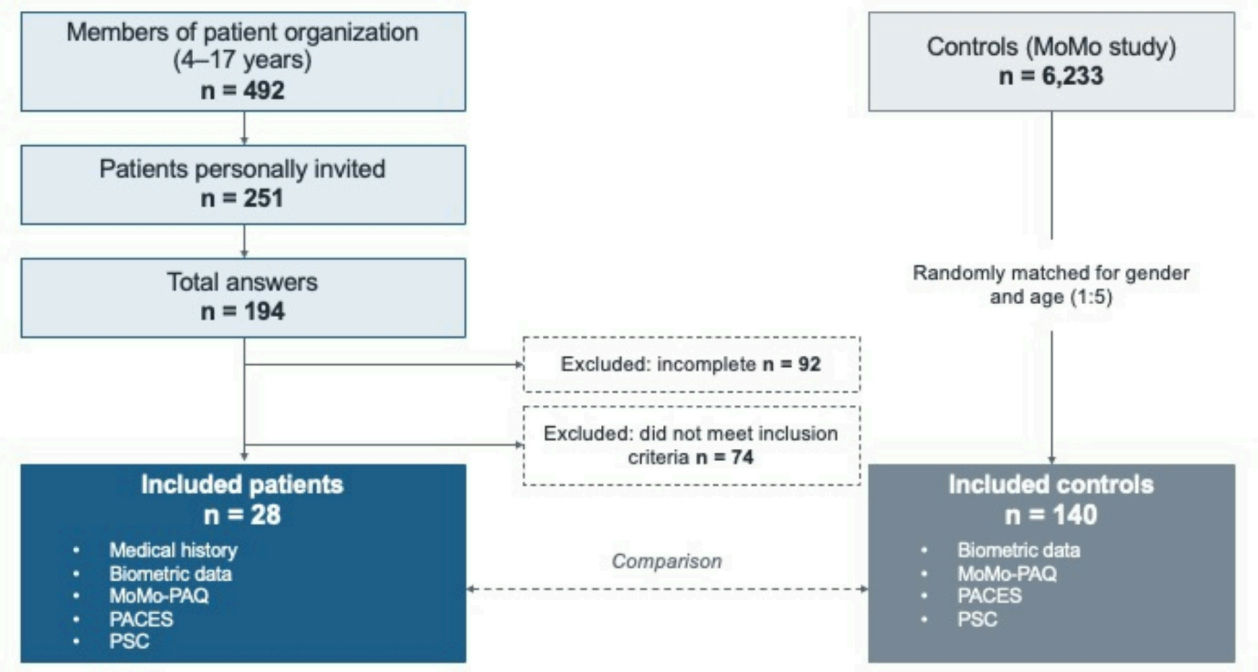

Figure 1

Inclusion flow-chart

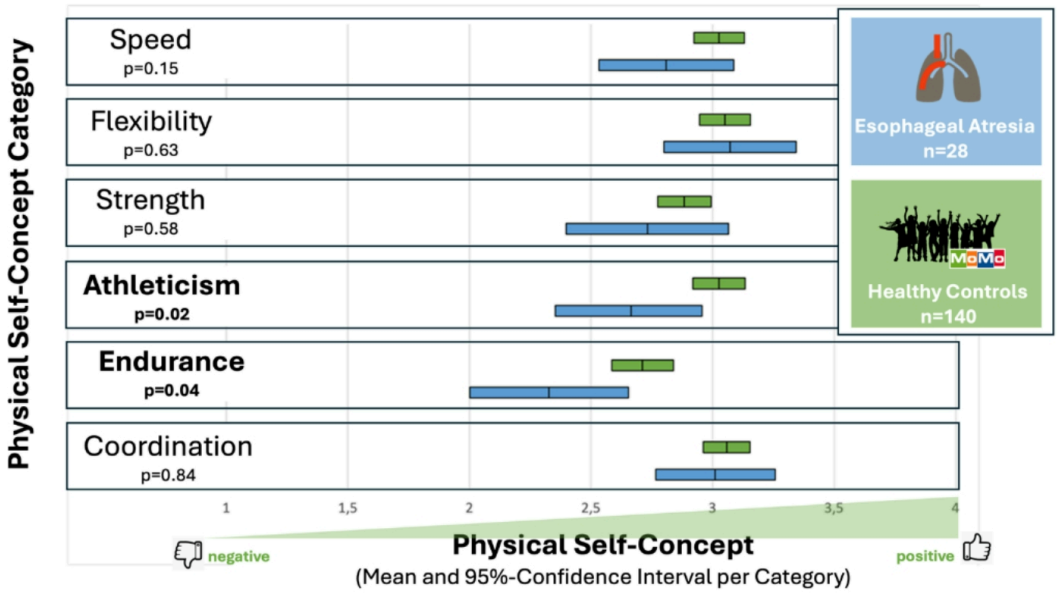

Figure 2

Comparison of esophageal atresia physical self-concept (PSC) subdomains with healthy controls from MoMo study.

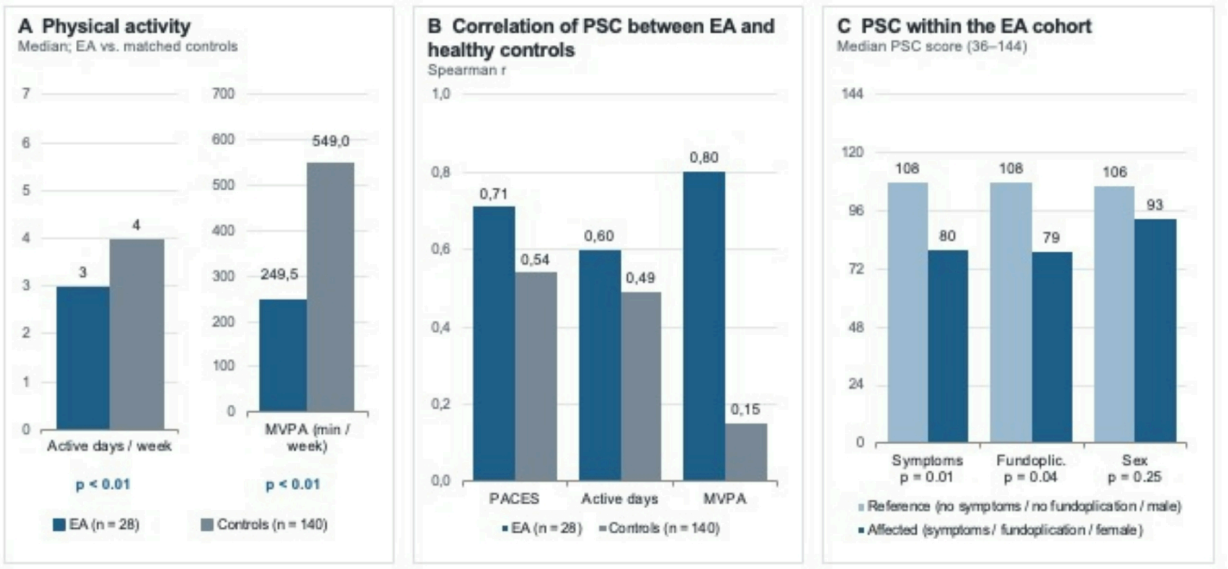

Figure 3

Correlation between physical self-concept and physical activity measures across study cohorts. Data are Spearman correlation coefficients (r) between overall physical self-concept (PSC) and the respective outcome. MVPA = moderate-to-vigorous physical activity; PACES = Physical Activity Enjoyment Scale. Group comparisons: Mann–Whitney U test.