# Outcomes of Adolescent-Onset Postural Orthostatic Tachycardia Syndrome

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**Objectives** To determine the clinical course of adolescent-onset postural orthostatic tachycardia syndrome (POTS) and to assess health-related quality of life, 2-10 years after diagnosis.

**Study design** Pediatric patients, 13-18 years of age, diagnosed with POTS at Mayo Clinic, Rochester, from 2003 to 2010 were mailed a questionnaire if they were at least 18 years of age at the time of the mailing. The primary outcome measures were norm-based, age- and sex-adjusted, 36-Item Short Form Health Survey physical composite score and mental composite score.

**Results** The survey was mailed to 502 patients with a response rate of 34% (n = 172). The mean duration from diagnosis to survey completion was 5.4 (SD, 1.9) years; the mean age of the respondents at the time of the survey was 21.8 (2.2) years. The responders were predominantly females (84% vs 68% of nonresponders; $P < .001$). Only 33 (19%) respondents reported complete resolution of symptoms, and an additional 51% reported persistent but improved symptoms, and 28 (16%) had only intermittent symptoms. The majority (71%) consider their health at least "good." The mean physical composite score was significantly lower than the population norm (mean [SD], 36.6 [15.8] vs 50; $P < .001$), however, the corresponding mean mental composite score was normal (50.1 [11.2]).

**Conclusions** Overall, 86% of adolescents with POTS report resolved, improved, or just intermittent symptoms, when assessed via questionnaire at an average of 5 years after initial treatment. Patients with persistent symptoms have more physical than mental health concerns. *(J Pediatr 2016;173:149-53)*.

Postural orthostatic tachycardia syndrome (POTS, sometimes also called postural tachycardia syndrome) is a potentially debilitating condition characterized by orthostatic intolerance, chronic fatigue, and, often, a variety of other symptoms.[1,2] It occurs in up to 1% of the adolescent population and affects females more than males. Symptoms often begin after an illness such as infectious mononucleosis or an injury such as a concussion.[1,3] Comorbidities can occur, including pain, gastrointestinal disorders, sleep disturbances, and psychosocial challenges.[4,5] POTS is diagnosed when an adolescent patient: (1) has chronic symptoms such as dizziness, nausea, and/or vision change that are linked to assuming or maintaining an upright position; (2) also has an excessive increase in heart rate within 10 minutes of assuming an upright position (at least a 40 beats per minute change during standardized passive tilt testing); and (3) does not have an alternate explanation for the symptoms.[1] Treatment includes: (1) enhancement of vascular volume by increased oral fluid and salt intake (though the details of a "best practice" of salt intake have not been defined); (2) regular aerobic exercise; (3) biobehavioral strategies; and (4) medications (such as fludrocortisone, beta blockers, midodrine, and selective serotonin reuptake inhibitors).[1]

POTS can be associated with severely impaired tolerance of academic and athletic activities.[1] Anecdotally, however, most affected adolescents eventually recover and do well. Unfortunately, there are limited data regarding actual outcomes in adolescents with POTS. In a follow-up survey 9-50 (mean 20) months after initiation of treatment, some general improvement was noted in 76% of adolescent respondents.[6] In a 12-month follow-up study combining adolescents and adults with POTS, orthostatic symptoms improved in 70%, and 37% no longer met diagnostic criteria for POTS; data were not analyzed separately for the adolescent subgroup in this study.[7] A study of Chinese children with a variety of types of orthostatic intolerance suggested that the degree of improvement relates to the initial extent of symptoms.[8] An adult study showed a usually benign outcome with good return to daily activities 1-12 years after initial evaluation.[9] The current study was designed to document improvement in symptoms and health-related quality of life in a cohort of adolescents with POTS.

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| MCS | Mental component scale |
| PCS | Physical component scale |
| POTS | Postural orthostatic tachycardia syndrome |
| SF-36 | 36-Item Short Form Health Survey |

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## Methods

Potential study subjects included patients, 13-18 years of age, diagnosed with POTS at the Mayo Clinic, Rochester, Minnesota during 2003-2010 who were at least 18 years of age at the time of the questionnaire mailing in 2013. A diagnosis of POTS was defined by orthostatic intolerance with a postural tachycardic increase of at least 40 beats per minute on 10-minute 70-degree head-up tilt table testing.

Patients with severe anemia, inflammatory rheumatologic disorders, adrenal insufficiency, diabetes, and other serious systemic illnesses were excluded from the study. In addition, patients who denied access to their medical records for research purposes or who were deceased at the time of the mailing were not included.

The study was approved by the Mayo Clinic Institutional Review Board. A questionnaire was mailed to all patients who met the above inclusion criteria. Nonresponders were re-mailed the questionnaire 1 month later. The questionnaire included the 36-Item Short Form Health Survey (SF-36), which is a validated self-reported tool composed of questions regarding health status, feelings, and ability to do usual activities.[10] The SF-36 score is broken down into 2 summary scales derived from 8 subscales. The physical component scale (PCS) is composed of physical functioning, physical role functioning, bodily pain, and general health subscales. The mental component scale (MCS) is composed of vitality, social functioning, emotional role functioning, and mental health subscales. The questionnaire also included additional items about current symptoms, change in symptoms since the initial diagnosis, medication use, amount of exercise, amount of employment or school days missed as a result of health, and current salt and fluid intake.

### Statistical Analyses

Statistical analysis was performed using the SAS v 9.2 software package (SAS Institute, Cary, North Carolina). Data were summarized using standard descriptive statistics: frequency and percentage for categorical variables and mean and SD or median and IQR for continuous variables. Sex distribution and age at diagnosis were compared between survey responders and nonresponders using the $\chi^2$ test and 2-sample *t* test, respectively. Age- and sex-adjusted standardized z-scores were derived for each of the 8 SF-36 subscales using responses from 18- to 24- and 25- to 34-year-olds in the general US population to the 1998 National Survey of Functional Health Status that included the SF-36.[11] The PCS and MCS scores were derived using the established scoring algorithm and transformed to norm-based (mean = 50, SD = 10) scores.[12] The norm-based PCS and MCS scores were each compared against a fixed population mean of 50 using a 1-sample *t* test. Additional comparisons between groups (recovered vs not recovered, with vs without symptoms) of continuous measures were evaluated using the 2-sample *t* test. All calculated *P* values were 2-sided and *P* values less than .05 were considered statistically significant.

## Results

Surveys were sent to 502 patients who met the inclusion criteria; responses were received from 172 (34%) patients. Respondents were more likely to be female ($P < .001$) and slightly older ($P = .013$). Among the 172 respondents, 144 (84%) were female and the mean age at diagnosis was 16.5 (SD, 1.3) years, compared with 226 (68%) and 16.1 (1.4) years for the 330 nonresponders. The mean duration from diagnosis to survey completion was 5.4 (1.9) years (range, 2.2-9.8 years). The mean age of respondents at the time of survey completion was 21.8 (2.2) years, ranging from 18.1-27.4 years. Of the 159 respondents between the ages of 18 and 24 years at the time of the survey, 129 (81%) had some college or technical training (nationally, 41% of all US 18- to 24-year-olds have some college training according to the National Center for Educational Statistics). Of the 53 respondents who were over 23 years of age at the time of the survey, 26 (49%) had graduated from college.

One hundred twenty-four (72%) respondents reported having used beta blockers sometime since their diagnosis, and 47 (27%) respondents reported current use of beta blockers at the time of the survey. Forty-eight (28%) respondents reported using a selective serotonin reuptake inhibitor; 20 (12%) respondents reported current use for their POTS management.

When asked their opinion on the treatment(s) that led to the greatest improvement in symptoms, 82 (48%) respondents affirmed the use of generous fluid intake, followed by conditioning (77, 45%), a high salt diet (77, 41%), beta blocker (50, 29%), midodrine (27, 16%), and selective serotonin reuptake inhibitor (13, 8%). Thirty-three (20%) respondents reported needing increased salt, water, and exercise to stay symptom free; 78 (45%) were still on a high-salt diet.

At the time of the survey, 122 (71%) respondents reported being in excellent, very good, or good health. Overall, 148 (86%) respondents reported on follow-up that their symptoms were resolved, improved, or just intermittent (**Figure 1**). Complete resolution of POTS-related symptoms (ie, “recovered”) was reported by 33 (19%) respondents (36% of males and 16% of females, $P = .015$). Despite endorsing that their symptoms completely resolved, a small portion of the “recovered” patients still reported experiencing symptoms at the time of the survey compared with the not “recovered” patients (**Figure 2**). Time from diagnosis to survey was not different in those who reported recovery vs nonrecovery (mean [SD], 5.7 [1.9] vs 5.3 [1.9] years, $P = .23$). The frequencies of symptoms at the time of the survey are summarized in the **Table**.

The mean norm-based, sex- and age-adjusted PCS score was 36.6 (15.8); this is significantly lower than the population norm of 50 ($P < .001$). The mean PCS score was significantly higher for the 33 patients reporting complete resolution of symptoms compared with the remaining survey respondents