

Increase in children with postural tachycardia syndrome after the COVID-19 pandemic

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Short Report

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Abstract

Background: The number of children diagnosed with orthostatic intolerance (OI) has been increasing. In adults, diagnoses of postural tachycardia syndrome (POTS), a type of OI, increased markedly after the COVID-19 pandemic. However, few studies have documented long-term changes in the number of children with POTS before and after the pandemic. This study aimed to examine the increase in the number of children diagnosed with POTS after the COVID-19 pandemic.

Methods: The participants included 624 children aged 12–15 years who underwent orthostatic tests at Kansai Medical University Medical Center between 2014 and 2025. Background characteristics and orthostatic test results were extracted from medical records.

Results: A total of 439 of 624 children were diagnosed with OI. POTS was the most common subtype, affecting 281 of 439 (64.0%) children. The number of POTS cases increased by 84% (from 99 to 182) between the 6-year periods before and after the COVID-19 pandemic. Analysis by 3-year intervals showed that the proportion of POTS had been increasing even before the pandemic and reached its highest level during 2020–2022, when unexpected school closures and behavioral restrictions were implemented in Japan.

Discussion: The increase in POTS was already evident before the pandemic and peaked during 2020–2022. Activity restrictions and psychosocial stress during the pandemic may have amplified this pre-existing trend through physical deconditioning and exacerbation of POTS symptoms.

Conclusion: The number and proportion of children with POTS increased following the COVID-19 pandemic.

Introduction

Diagnoses of postural tachycardia syndrome (POTS) have increased after the COVID-19 pandemic [1]. POTS and orthostatic intolerance (OI) are common manifestations among patients with long COVID [2]. Although several studies have described POTS after COVID-19 in adults [3], pediatric data remain limited.

OI is characterized by an impaired circulatory response to orthostatic stress and commonly affects children and adolescents [4,5]. Symptoms include dizziness, headache, palpitations, and fatigue, often resulting in school absenteeism and reduced quality of life [4-6]. Compared with healthy children, those with OI have lower quality-of-life scores across physical, mental, self-esteem, peer, and school domains and more depressive symptoms [6]. Therefore, clarifying the mechanisms and risk factors of OI in children and adolescents is important.

Multiple guidelines are available for the diagnosis of OI/POTS. In Japan, OI is referred to as orthostatic dysregulation (OD), and the Japanese clinical guidelines classify OD into four subtypes: instantaneous orthostatic hypotension (INOH), postural tachycardia syndrome (POTS), delayed orthostatic hypotension (delayed OH), and vasovagal syncope (VVS) [4]. Among these subtypes, INOH was previously reported to be more prevalent [7]. Recent studies have reported increasing numbers of patients with POTS [8,9].

During the COVID-19 pandemic, which began in 2020, school closures and activity restrictions reduced physical activity among children and adolescents. A decline in physical fitness during the pandemic has been reported, suggesting deconditioning associated with prolonged inactivity [10,11]. Deconditioning is defined as reversible changes and loss of function in body systems caused by physical inactivity [12] and is closely related to the pathophysiology of POTS, in which exercise intolerance and physical deconditioning are recognized features [13,14]. POTS-related reductions in activity and subsequent deconditioning may further exacerbate POTS symptoms, creating a vicious cycle [15].

The pandemic had significant negative effects on children's health, including increased anxiety and depression [16], and may have been associated with an increase in OI, particularly POTS, among children and adolescents

[17,18]. However, no studies have examined long-term changes in the number of pediatric patients with POTS in detail before and after the COVID-19 pandemic.

Thus, to the best of our knowledge, this 12-year retrospective study is the first to document long-term changes in the number of pediatric patients with POTS before and after the COVID-19 pandemic in a pediatric clinic.

Methods

Participants

This study enrolled 632 patients aged 12–15 years who underwent orthostatic tests between January 2014 and December 2025 at the Division of Pediatrics, Kansai Medical University Medical Center, for suspected OI. All patients had at least three symptoms suggestive of OI [4]. Blood tests, urine tests, X-rays, and electrocardiograms were performed to exclude hematologic, endocrine, and cardiac diseases. Patient characteristics were extracted from medical records.

Orthostatic test

Patients underwent a 10-min 90° head-up tilt test. Blood pressure and pulse rate were measured every minute using the KM385-OD device. On the day of testing, patients were instructed to withhold midodrine and β -blockers. All tests were performed by the same physician experienced in OI throughout the 12-year study period.

Diagnostic criteria of pediatric OI in Japan

OI was diagnosed according to the clinical guidelines for juvenile OD published by the Japanese Society of Psychosomatic Pediatrics [4]. Patients were classified into four subtypes: INOH, POTS, VVS, and delayed OH. INOH was defined as an orthostatic recovery time of <25 s; delayed OH as a decrease in systolic blood pressure of >20 mm Hg or >15% at 3–10 min after standing; VVS as a sudden drop in blood pressure and loss of consciousness during orthostasis; and POTS as a pulse rate of >115 bpm or an increase in heart rate of >35 bpm without a decrease in blood pressure.

Protocol

The distribution of OI subtypes over the 12-year study period was analyzed. To evaluate changes before and after the COVID-19 pandemic, 2020 was defined as the pandemic year, and the numbers and proportions of OI subtypes were compared between the pre-pandemic (2014–2019) and post-pandemic (2020–2025) periods. Statistical comparisons were performed using Fisher's exact test, with $p < 0.05$ considered statistically significant.

Ethical approval

The study protocol was approved by the Ethics Committee of Kansai Medical University Medical Center (#2024036).

Results

OI prevalence

Among the 632 patients, 439 were diagnosed with OI (Figure 1). The median age was 12.5 years, and 226 patients were male (51.5%). POTS was the most prevalent subtype, affecting 281 patients (64.0%).

Increase in POTS after the COVID-19 pandemic

The number of patients with OI increased from 183 in the pre-pandemic period to 256 in the post-pandemic period (Table). The number and proportion of POTS cases increased significantly from 99 (54.1%) to 182 (71.1%) ($p < 0.001$). In contrast, the proportion of INOH decreased from 39 (21.3%) to 29 (11.3%) ($p = 0.0044$). No significant differences in age, sex, or the other two subtypes were observed between the groups.

Trends in POTS prevalence before, during, and after the COVID-19 pandemic

To evaluate temporal changes in the proportion of POTS during and after the COVID-19 restriction period, patients were analyzed in four 3-year intervals: 2014–2016, 2017–2019, 2020–2022, and 2023–2025. The proportion of POTS increased across the study periods and was highest during 2020–2022 (97/134 [72.4%])

(Figure 2). No significant differences in age or sex were observed among the four groups.

Discussion

This study analyzed orthostatic test data collected over 12 years using a consistent protocol performed by the same physician. This longitudinal dataset allowed us to evaluate changes in OI subtypes over time. We found that POTS was the most common OI subtype and that its proportion increased after the COVID-19 pandemic, reaching the highest level during 2020–2022, when school closures and behavioral restrictions were implemented in Japan. The decrease in the proportion of INOH may reflect the relative increase in POTS cases.

POTS is a syndrome characterized by a sustained increase in heart rate during standing and was first described in the 1990s [18]. Although orthostatic hypotension is absent, patients experience symptoms such as lightheadedness, palpitations, fatigue, and headache, which typically improve in the supine position [19]. The epidemiology and pathogenesis of POTS remain incompletely understood. Current evidence suggests that POTS results from multiple mechanisms, including autoimmune abnormalities, increased sympathetic activity, connective tissue abnormalities, autonomic dysfunction, and physical deconditioning [19-21].

We hypothesize that deconditioning due to physical activity restrictions during the COVID-19 pandemic contributed to the increase in POTS cases. Bed-rest studies lasting 7–20 days have shown that young, healthy individuals experience reductions in heart and blood volumes and marked tachycardic responses to standing or head-up tilt [22,23]. In addition, deconditioning may contribute to the exacerbation of neuropathic, hypovolemic, autoimmune, and hyperadrenergic features of POTS [21].

In recent years, children in Japan have become less physically active due to lifestyle changes, including increased use of smartphones and video games [24]. Thus, the increase in POTS before the pandemic may partly reflect pre-existing changes in children's lifestyles. These trends may have been further amplified by school closures and activity restrictions during the COVID-19 pandemic. COVID-19-related restrictions have been reported to induce physical deconditioning even in healthy children [11]. In addition, disrupted daily routines, reduced social

interaction, and psychosocial stress during the pandemic may have exacerbated autonomic and somatic symptoms and further reduced physical activity [25]. Thus, deconditioning and psychosocial stress may have interacted to contribute to the manifestation or exacerbation of POTS symptoms.

This study has several limitations. First, we did not measure COVID-19 antibody levels or collect vaccination histories, precluding evaluation of their associations with long COVID. Moreover, although POTS is considered a manifestation of long COVID, it remains unclear whether these cases represent POTS or POTS-like symptoms, as noted by the Pediatric Writing Group of the American Autonomic Society [5]. Since the beginning of the pandemic, patients with fever or cough within two weeks before their hospital visit have not undergone orthostatic testing at our institution. Therefore, the effect of acute COVID-19 infection on our findings is likely limited.

Second, we lacked individual data on physical activity and psychosocial stress during the COVID-19 pandemic. Therefore, their respective contributions to the increase in POTS could not be determined.

Third, this single-center study may not be representative of Japan or other populations. However, given the limited epidemiological data on pediatric POTS associated with the COVID-19 pandemic, these findings provide preliminary evidence of an increase in the number and proportion of diagnosed POTS cases after the pandemic. Multicenter registry studies in Japan and internationally are needed to further clarify the epidemiology and pathophysiology of pediatric POTS.

Conclusion

The number and proportion of children diagnosed with POTS increased following the COVID-19 pandemic.

List of abbreviations

169 OI, orthostatic intolerance; OD, orthostatic dysregulation; delayed OH, delayed orthostatic hypotension;
170 INOH, instantaneous orthostatic hypotension; POTS, postural tachycardia syndrome; VVS, vasovagal syncope
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Figure legends and tables:

Figure 1. Number and percentage of pediatric patients with OI by subtype over a 12-year period at Kansai Medical University Medical Center. Subtypes were classified into four categories based on orthostatic testing according to the Japanese Society of Psychosomatic Pediatrics guidelines. INOH, instantaneous orthostatic hypotension; POTS, postural tachycardia syndrome; delayed OH, delayed orthostatic hypotension; VVS, vasovagal syncope.

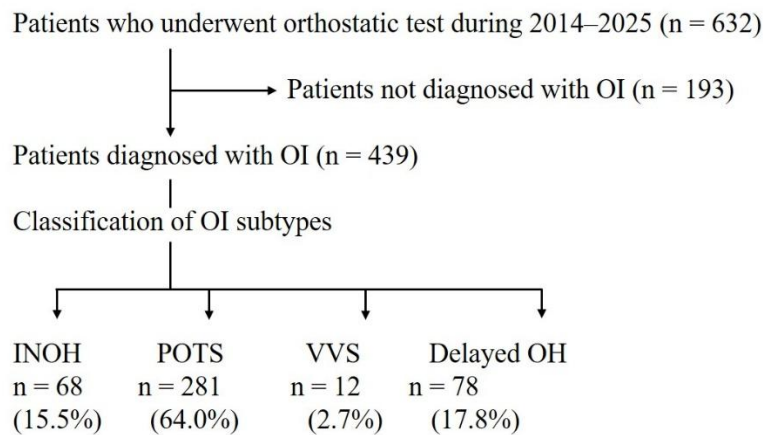


Figure 2. Number of patients with each OI subtype from 2014 to 2025, grouped into 3-year periods.

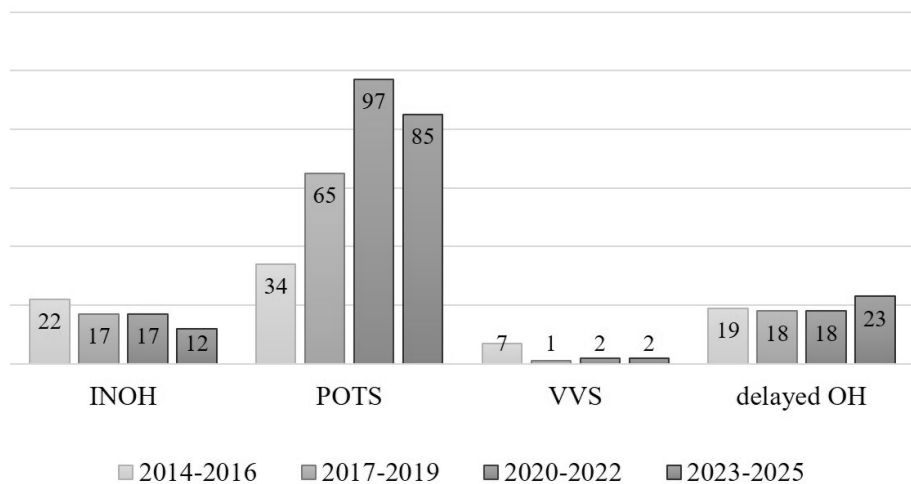


Table. Comparison of age, sex, and orthostatic intolerance (OI) subtypes between the 6-year periods before and

after the COVID-19 pandemic: 2014–2019 vs 2020–2025.

	Before the COVID-19 pandemic n = 183	After the COVID-19 pandemic n = 256	P value
Patient data			
Age (year), median	13.5 (12-15)	13.5 (12-15)	—
Male sex	94 (51.4%)	132 (51.6%)	0.968
OI subtypes			
INOH	39 (21.3%)	29 (11.3%)	0.0044
POTS	99 (54.1%)	182 (71.1%)	0.00025
VVS	8 (3.4%)	4 (1.6%)	0.0751
delayed OH	37 (20.2%)	41 (16.0%)	0.935

delayed OH, delayed orthostatic hypotension; INOH, instantaneous orthostatic hypotension; POTS, postural
tachycardia syndrome; VVS, vasovagal syncope.

Declarations

- Ethics approval and consent to participate: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Kansai Medical University Medical Center (#2024036). The requirement for informed consent was waived by the Institutional Review Board because of the retrospective nature of the study.

- Consent for publication: Not applicable.

- Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

- Competing interests: This research have no competing interests.

- Funding: This research received no specific grant from any funding agency.

- Authors' contributions: Ryuhei Yoshida collected the data, prepared Figure1-2 and Table, and wrote the main manuscript text. Yuko Ishizaki, Yoshitoki Yanagimoto, Yuri Fuji, Toshiki Terashima, Sachiyo Tanaka, Kazunari Kaneko Yuko Ishizaki reviewed and edited the manuscript.

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