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Reporting of paediatric exercise-induced respiratory symptoms by physicians and parents: an observational prospective study

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Summary

STUDY AIMS: Routinely collected health data are increasingly used for research; however important anamnestic details may be missing from medical records. We compared physician documentation of paediatric exercise-induced respiratory symptoms in clinical notes with parental questionnaire responses for the same children.

METHODS: We analysed data from the Swiss Paediatric Airway Cohort (SPAC), a multicentre observational study of children treated in Swiss outpatient pulmonology clinics. We included children aged 6 to 17 years who were referred to a paediatric pulmonologist for evaluation of exercise-induced respiratory symptoms. Features of exercise-induced respiratory symptoms recorded by physicians were extracted from outpatient clinic letters transmitted to the referring physician, while parent-reported exercise-induced respiratory symptom data was collected from a standardised questionnaire completed at Swiss Paediatric Airway Cohort enrolment. We calculated agreement between physician-documented and parent-reported exercise-induced respiratory symptom characteristics using Cohen's and Fleiss's kappa.

RESULTS:Of 1669 children participating in the Swiss Paediatric Airway Cohort (2017–2019), 193 (12%) met the inclusion criteria, of whom 48% were girls. Physicians provided detailed information on exercise-induced respiratory symptoms in 186 (96%) outpatient clinic letters. Documented characteristics included: type of physical activity triggering exercise-induced respiratory symptoms (69%), location of exercise-induced respiratory symptoms in chest or throat (48%), respiratory phase of exercise-induced respiratory symptoms (45%) and timing of exercise-induced respiratory symptoms during or after exercise (37%). Previous bronchodilator use (94%) and its effect on exercise-induced respiratory symptoms (88%) were consistently documented by physicians. The clinic letters for children diagnosed with dysfunctional breathing more often contained detailed exercise-induced respiratory symptom characteristics than those diagnosed with asthma. The level of agreement between physician-documented and parent-reported exercise-induced respiratory symptoms was moderate for use of bronchodilators (κ = 0.53) and poor-to-fair for all other features (κ = 0.01–0.36).

CONCLUSION: This study highlights that outpatient clinic letters may lack some details on exercise-induced respiratory symptom characteristics – information that parents could provide. A standardised and detailed method for documenting paediatric respiratory symptoms in the coordinated data infrastructure may enhance future analyses of routinely collected health data.

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Introduction

Exercise-induced respiratory symptoms are common in childhood [1]. Symptom characteristics vary depending on the underlying respiratory aetiology [2–4], which may include asthma, dysfunctional breathing (e.g. inducible laryngeal obstruction, breathing pattern disorders) or insufficient fitness [5–9]. The domains of exercise-induced respiratory symptoms – such as timing of onset, severity, perceived location, relation to exercise intensity and duration, and response to treatment – are important features in the clinical history. Exercise-induced wheeze, cough and chest tightness are common in asthma [10, 11], while stridor and

dyspnoea are more often noted with extrathoracic dysfunctional breathing [9, 11]. Thoracic dysfunctional breathing is associated with exertional dyspnoea, sighing and dizziness, and may be accompanied by hyperventilation [12]. Poor differentiation between isolated or co-existing dysfunctional breathing and other entities may lead to misdiagnosis, overtreatment (e.g. inhaled corticosteroids) and excess healthcare costs [13, 14]. Thus, detailed history-taking is essential for evaluating the differential diagnosis in children referred with exercise-induced respiratory symptoms.

With the advent of electronic health record databases and the creation of clinical data repositories, also known as coordinated data infrastructures, secondary use of routinely collected health data to promote public health research is evolving [15]. The sharing of depersonalised health data will be increasingly important for enhancing the understanding, management and prevention of disease [16]. The Swiss Personalised Health Network (SPHN) aims to improve the utilisation of data obtained during routine healthcare encounters by facilitating accessibility for research [17]. Swiss paediatricians agreed to uniformly capture a minimal set of variables in medical records [18], but recording of symptoms has not been standardised yet.

To our knowledge, the comprehensiveness of documentation of exercise-induced respiratory symptoms in outpatient clinic letters has not been previously studied. This information is important for understanding the usability of exercise-induced respiratory symptom-related data for healthcare research through, for example, text search or similar methods. We analysed the characteristics of exercise-induced respiratory symptom documentation in outpatient clinic letters and assessed the level of agreement with parental information from a standardised questionnaire.

Materials and methods

Study design

We used data from the Swiss Paediatric Airway Cohort (SPAC), a national multicentre longitudinal study of children evaluated in outpatient paediatric pulmonology clinics throughout Switzerland (ClinicalTrials.gov identifier: NCT03505216) [19–22]. The SPAC study aims to enrol all children referred to the pulmonology clinics for respiratory problems such as wheezing, coughing, dyspnoea and exercise-related symptoms. The SPAC study is observational and embedded in routine medical care, and all diagnostic tests are performed per clinical indication. Recruitment started in July 2017 and is ongoing.

In conjunction with SPAC study enrolment, parents complete a baseline questionnaire, which collects data related to respiratory symptoms, medication utilisation, environmental exposures and health behaviours at the time of referral. On the first page of the standardised questionnaire, written instructions encourage the parent(s) to involve the child in questionnaire completion. The baseline questionnaire was modelled on questions developed for the International Study of Asthma and Allergies in Childhood (ISAAC) [23] and the Leicester Respiratory Cohort (LRC) [24], in conjunction with physician input. The questions related to exercise-induced respiratory symptoms were developed *de novo* by the authors (EP, CdJ, CK) and revised in conjunction with the Swiss Paediatric Airway Cohort project collaborators, who are paediatric pulmonologists. The SPAC baseline questionnaire was tested among parents who provided comments related to construct and face validity, and the questionnaire was adapted based on this feedback.

The baseline questionnaire was completed by the parent either shortly before or shortly after their child's consultation with the paediatric pulmonologist and enrolment in the SPAC study. Neither the child's referring physician nor the paediatric pulmonologist reviewed the questionnaire responses, which were exclusively analysed by the SPAC research team. We also collected data from medical records, including the reason for referral, diagnostic investigations, final diagnosis, and prescribed treatment. All data was entered into a Research Electronic Data Capture (REDCap) database [25]. Written informed consent was obtained at enrolment from parents and directly from participants aged over 13 years. The SPAC study was approved by the Bern Cantonal Ethics Committee (Kantonale Ethikkomission Bern 2016-02176) and the SPAC study protocol was published [19]. A separate protocol for this analysis of exercise-induced respiratory symptom documentation was not independently published.

Inclusion criteria

We included children aged 6–17 years who enrolled in the SPAC study between 1 July 2017 and 1 December 2019 and who had been primarily referred to the paediatric pulmonology clinic for exercise-induced respiratory symptoms. We considered exercise-induced respiratory symptoms to be the main reason for referral when the referral letter or the first outpatient clinic letter listed exercise-induced respiratory symptoms as the sole or main reason for specialist consultation.

Physician-documented and parent-reported exercise-induced respiratory symptom data

We obtained physician-documented exercise-induced respiratory symptom data from the outpatient clinic letter that was transmitted to the referring physician. Physicians' notes were individually reviewed by a SPAC investigator (EP), and relevant data was manually extracted from the text. For any unclear physician notes, a second reviewer (CdJ) independently examined the document, and the final extracted data was based on agreement between the two reviewers. Extracted data included: symptom(s) experienced by the child (e.g. wheezing, coughing, dyspnoea, tingling in fingertips or lips); perceived symptom location (chest or throat); respiratory phase in which symptoms occurred or were felt maximally (inspiration or expiration); triggers of exercise-induced respiratory symptoms (specific physical activities); timing of onset of exercise-induced respiratory symptoms (during or after exercise); and use and effect of bronchodilator treatment on exercise-induced respiratory symptoms (table 1). Parent-reported exercise-induced respiratory symptom data was extracted from the baseline questionnaire (EP) (table 1).

Medical diagnosis associated with exercise-induced respiratory symptoms

The final diagnosis assigned by the paediatric pulmonologist was extracted from the outpatient clinic letter. We grouped diagnoses into five major categories consistent with published literature: (1) asthma, (2) extrathoracic dysfunctional breathing (functional: inducible laryngeal obstruction; structural: e.g. laryngomalacia, tracheomalacia), (3) thoracic dysfunctional breathing (functional: exercise-induced respiratory symptoms with hyperventilation, breathing pattern disorders), (4) asthma plus dysfunctional breathing (for patients with co-existing diagnoses), and (5) other diagnoses (e.g. insufficient fitness level, chronic cough or rare pulmonary causes) [6, 8].

Statistical analysis

We compared proportions of physician-documented and parent-reported exercise-induced respiratory symptoms using counts and percentages. We calculated the level of agreement for specific characteristics among children where the characteristic was mentioned in both the outpatient clinic letter and the parental questionnaire – e.g. for onset of symptoms, we calculated agreement for whether symptoms started during or after exercise if the clinic letter included information on the timing of onset. Children for whom this characteristic was not mentioned in the clinic letter were excluded from this analysis. We calculated kappa statistics using Cohen's kappa for dichotomous outcomes and Fleiss' kappa for categorical variables with more than two categories. The kappa was interpreted using Landis and Koch's criteria: 0.0–0.2 slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement and 0.81–1.0 almost-perfect to perfect agreement [26]. We also assessed whether agreement in exercise-induced respiratory symptoms depended on who filled in the baseline questionnaire (mother, father, child-assisted) using kappa statistics. We used STATA version 14 for statistical analyses and the analytical code is published as supplement 1 in the appendix.

Results

Of the 1669 children who participated in the Swiss Paediatric Airway Cohort (SPAC) study within the eligibility period, 193 (12%) met the inclusion criteria (table 2). The mean age was 12 years and 92 (48%) were girls. Most study participants were seen in Lucerne (33%) followed by Zurich (25%), Basel (17%), Aarau (12%), Bern (11%) and St. Gallen (2%). The final diagnosis from the paediatric pulmonologist was asthma in 106 patients (55%), extrathoracic dysfunctional breathing in 33 (overall 17%; functional in 30 [16%] and structural in 3 [1%]), thoracic dysfunctional breathing in 21 (11%), asthma plus dysfunctional breathing in 21 (11%) and other diagnoses in 12 (6%).

In the outpatient clinic letter, the characteristics of exercise-induced respiratory symptoms were documented in 186 (96%) of the 193 children. The type of symptom experienced with exercise was almost always noted by physicians (96%), followed by triggering physical activity (69%), perceived symptom location (48%), respiratory phase (45%) and onset of exercise-induced respiratory

Table 1:
Information extracted from the outpatient clinic letter (physician) and standardised questionnaire (parent) to measure the level of agreement in reporting of exercise-induced respiratory symptom characteristics. Total n = 193.

Variable	Physician documented exercise-induced respiratory symptoms, extracted from outpatient clinic letter	Question in Swiss Paediatric Airway Cohort questionnaire
Any exercise-induced respiratory symptoms	Does the child have any exercise-induced symptoms? [Yes | No | *Not mentioned*]	Does your child sometimes experience breathing problems when exercising? [Yes | No]
Wheezing	Does the child wheeze when exercising? [Yes | No | *Not mentioned*]	Which breathing problems does your child experience when exercising? Wheezing or whistling breathing sounds [Yes | No]
Coughing	Does the child cough when exercising? [Yes | No | *Not mentioned*]	Which breathing problems does your child experience when exercising? Cough [Yes | No]
Dyspnoea	Does the child experience dyspnoea, shortness of breathing, difficulty breathing when exercising? [Yes | No | *Not mentioned*]	Which breathing problems does your child experience when exercising? Dyspnoea or tightness [Yes | No]
Tingling in fingertips or lips	Does the child experience a tingling feeling in fingertips or lips while exercising? [Yes | No | *Not mentioned*]	Does your child sometimes experience a sensation as if ants were creeping around the fingertips or lips while exercising? [Yes | No]
Types of exercise-induced respiratory symptom triggers	Which of the following activities trigger exercise-induced symptoms? [Running | Bicycle riding | Intensive sport games | Swimming | Cold weather sports | *No exercise triggers specified*]	In which of the following situations do the breathing problems occur? [Running short distances | Running middle distances | Running longer distances | Biking | Sports games | Swimming]
Location of dyspnoea	Where are the exercise-induced symptoms felt the strongest? [Chest | Throat | Chest and throat | *Not specified*]	If dyspnoea or tightness, where is the sensation felt the strongest? [Chest | Throat | Everywhere (chest and throat)]
When are exercise-induced respiratory symptoms worst	In which respiratory phase are the exercise-induced symptoms worst? [During inspiration | During expiration | Equally during inspiration and expiration | *Not specified*]	When are the breathing problems worst? [During inspiration | During expiration | Equally during inspiration and expiration]
Onset of exercise-induced respiratory symptoms	When do the exercise-induced symptoms begin? [During exercise | After exercise | *Not specified*]	When do the breathing problems begin? – When your child, for example, runs a longer distance, then the breathing problems normally begin: (Choose one) [Straight away after the first steps | A few minutes after beginning the exercise | After ending the exercise]
Inhaled medications for exercise-induced respiratory symptoms	Has the child used any inhaled medication before or during exercise? [Yes | No | *Not mentioned*]	Has your child inhaled an asthma spray or asthma powder for breathing problems occurring when exercising? [Yes | No]
Effect of inhaled medications	If yes: How well does the medication help? [Symptoms disappear | Symptoms are reduced | No difference | *Not mentioned*]	If yes: How well does the medication help? (Choose one): [The breathing problems disappear | The breathing problems are reduced | You almost feel no difference]

symptoms relative to exercise (37%). Bronchodilator use prior to paediatric pulmonology consultation was very frequently documented in the outpatient clinic letter (94%), and the medication effect was noted in 88% of the letters. Overall, characteristics of exercise-induced respiratory symptoms were more often documented for children diagnosed with dysfunctional breathing than for children diagnosed with asthma or other diagnoses (figure 1).

Parents reported the type of respiratory symptom and triggering exercise more often than physicians (table 3). The most frequent symptom, exercise-induced cough, was indicated in 57% of parent-completed questionnaires versus 35% of clinic letters. Similarly, tingling in fingers or lips – the rarest symptom to be noted – was reported more often by parents (18%) than physicians (1%).

The highest agreement between physicians and parents was found for recording bronchodilator use ($\kappa = 0.53$). The agreement for type of symptom was best for cough ($\kappa = 0.39$) and wheezing ($\kappa = 0.24$) and lowest for tingling in lips or fingers ($\kappa = 0.09$). The agreement for exercise-induced respiratory symptom trigger was generally poor across the different categories of exercise ($\kappa = 0.01$–0.14). Perceived location of exercise-induced respiratory symptoms in the chest or throat ($\kappa = 0.36$) had better agreement

Table 2:
Characteristics of children referred to Swiss pulmonology outpatient clinics for exercise-induced respiratory symptoms (n = 193). Counts and percentages are in relation to the total sample of 193 children, unless otherwise indicated.

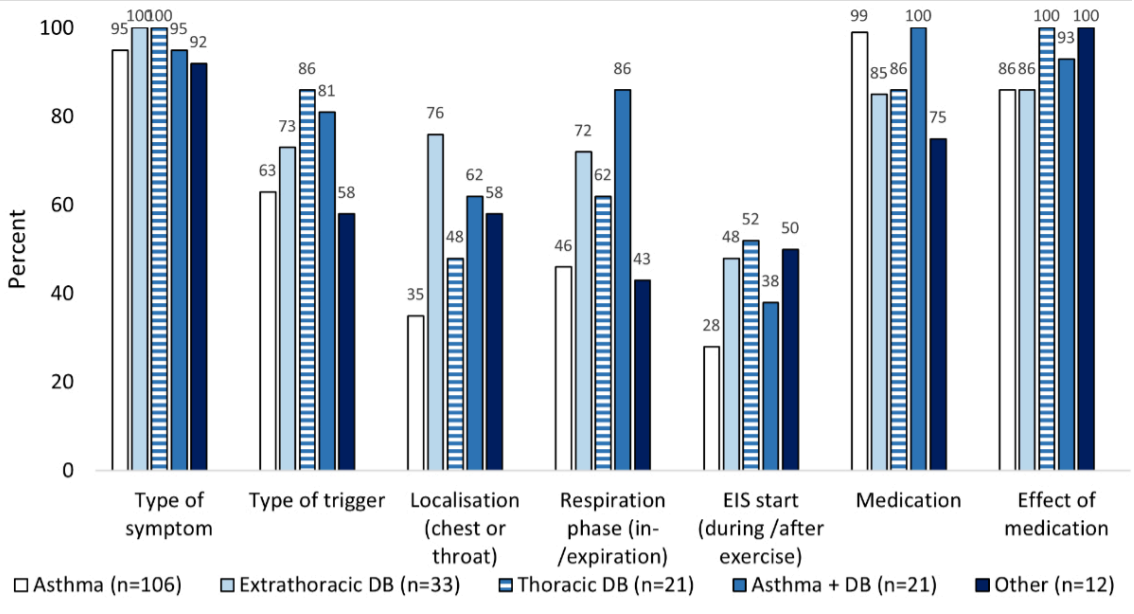
Characteristic		**n (%)**
Age at baseline visit in years, mean (SD)		12 (3)
Female sex		92 (48%)
BMI z-score, mean (SD) (n = 161)		0.4 (1.1)
Overweight (BMI z-score >1) (n = 161)		49 (25%)
Performs leisure-time sports* (n = 191)		164 (86%)
Swiss nationality		159 (82%)
Parental education (n = 185)	Mother, tertiary**	55 (30%)
	Father, tertiary**	75 (41%)
Current smoking (n = 190)	Mother	28 (15%)
	Father	34 (19%)
Respiratory symptoms in past 12 months (parental questionnaire) (n = 190)	Wheezing	105 (54%)
	>3 attacks of wheezing	58 (30%)
	Any symptoms during exercise	175 (94%)
Physician diagnosis	Asthma	106 (55%)
	Extrathoracic dysfunctional breathing	33 (17%)
	Thoracic dysfunctional breathing	21 (11%)
	Asthma plus dysfunctional breathing	21 (11%)
	Other aetiology of exercise-induced respiratory symptoms	12 (6%)

BMI: body mass index; SD: standard deviation.

* Apart from school-based sports

** Degree from university of applied sciences or university

Figure 1: Exercise-induced symptoms documented by the physician in the outpatient clinic letter, by final diagnosis (n = 193). Numbers displayed above each column indicate the exact percentage of documentation of each exercise-induced respiratory symptom (EIS) in the outpatient clinic letter. DB: dysfunctional breathing.



than respiratory phase of symptoms (κ = 0.13) and timing of exercise-induced respiratory symptom onset (κ = 0.19). Agreement between physician-documented and parent-reported exercise-induced respiratory symptoms differed for single items depending on who filled in the questionnaire (mother, father, child-assisted), but overall agreement was not better for one subgroup.

Discussion

This study is the first to describe characteristics of documentation of exercise-induced respiratory symptoms by paediatric pulmonologists among children enrolled in a large paediatric respiratory cohort and referred primarily for exercise-induced respiratory symptoms. Outpatient clinic letters usually included information related to specific symptom(s) and bronchodilator use, but less often provided important additional details such as perceived symptom location, respiratory phase and timing of onset of exercise-induced respiratory symptoms. These characteristics of exercise-induced respiratory symptoms have been described as important factors for differentiating dysfunctional breathing from asthma and other aetiologies [3, 11, 27–29]; however this information was documented in the outpatient clinic letter of less than half of the children.

There can be several reasons why physicians documented fewer anamnestic details about exercise-induced respiratory symptoms in the outpatient clinic letter compared to what parents conveyed in the standardised questionnaire. Paediatric pulmonologists may have chosen to document only the most important symptoms in the outpatient clinic report, where succinct summarisation is an important consideration for both the writer (treating physician) and reader (referring physician). It is also possible that physicians verbally enquired about all exercise-induced respiratory symptom domains but underreported negative responses in the outpatient clinic report. Another explanation concerns different intrinsic characteristics of the data collection tools. Whereas medical documentation is usually flexible and unique to each physician, parental questionnaires relied on a standardised checklist of specific symptoms and preformulated response choices. In addition, the doctor may directly explain or display what is meant by the question, an advantage which is not available in a standardised questionnaire and which can lead to different answers.

Interestingly, we observed consistent differences in the extent of exercise-induced respiratory symptom documentation by physicians, depending on the final diagnosis. When the final diagnosis was extrathoracic or thoracic dysfunctional breathing, all exercise-induced respiratory symptom

Table 3:
Level of agreement between physician-documented and parent-reported exercise-induced respiratory symptoms (n = 193). We analysed the level of agreement if the characteristic in question was mentioned both in the physician's outpatient clinic letter and the parental questionnaire; thus characteristics that were missing in both documents were excluded from this analysis. The n is provided for each characteristic (out of the total 193 children).

		Physician-documented	Parent-reported	Agreement between physician-documented and parent-reported exercise-induced respiratory symptoms				Kappa
				Physician+ Parent+	Physician+ Parent–	Physician– Parent+	Physician– Parent–	
Symptom (n = 175)	Wheezing or whistling sounds	56 (32%)	101 (58%)	43 (25%)	13 (7%)	58 (33%)	61 (35%)	0.24
	Coughing	61 (35%)	100 (57%)	52 (30%)	9 (5%)	48 (27%)	66 (38%)	0.39
	Dyspnoea	114 (65%)	146 (83%)	101 (58%)	13 (7%)	45 (26%)	16 (9%)	0.17
	Tingling in fingers/lips	2 (1%)	31 (18%)	2 (1%)	0	29 (16%)	145 (82%)	0.09
Type of exercise triggering exercise-induced respiratory symptoms (n = 121)	Running	44 (36%)	75 (62%)	30 (25%)	14 (12%)	45 (37%)	32 (26%)	0.08
	Biking	18 (15%)	79 (65%)	17 (14%)	1 (1%)	62 (51%)	41 (34%)	0.14
	Intensive sports	81 (67%)	94 (78%)	63 (52%)	18 (15%)	31 (26%)	9 (7%)	0.01
	Swimming	8 (7%)	46 (38%)	8 (7%)	0	38 (31%)	75 (62%)	0.22
Symptom location (n = 73)								0.36
	Chest	40 (55%)	41 (56%)	*				
	Throat	26 (36%)	12 (16%)					
	Chest and throat	7 (10%)	20 (27%)					
Respiratory phase (n = 94)								0.13
	Inspiration	47 (50%)	47 (50%)	*				
	Expiration	37 (39%)	5 (5%)					
	Inspiration and expiration	10 (11%)	42 (45%)					
Timing of exercise-induced respiratory symptom onset (n = 66)								0.19
	During exercise	45 (68%)	55 (83%)	40 (61%)	5 (8%)	15 (23%)	6 (9%)	
	After exercise	21 (32%)	11 (17%)	6 (9%)	15 (23%)	5 (8%)	40 (61%)	
Prior use of bronchodilator for exercise-induced respiratory symptoms (n = 159)								0.53
	Yes	99 (62%)	111 (70%)	88 (55%)	11 (7%)	23 (14%)	37 (23%)	
Effect of bronchodilator (n = 76)								0.27
	Exercise-induced respiratory symptoms disappear	23 (30%)	17 (22%)	*				
	Exercise-induced respiratory symptoms reduce	29 (38%)	42 (55%)					
	No difference	24 (32%)	17 (22%)					

* Cell percentages cannot meaningfully be displayed because the variable is not dichotomous. This data is separately provided in supplement 2 in the appendix.

domains (type of symptom, type of trigger, location, respiratory phase of symptom and timing of exercise-induced respiratory symptoms) were more frequently documented in the outpatient clinic letter than when the final diagnosis was asthma. We can speculate that since these diagnoses are relatively rarer than asthma and are less likely to rely on objective diagnostic tests, paediatric pulmonologists may have documented more symptom characteristics to communicate differential diagnosis evaluation and clinical decision-making to the referring physician.

Agreement on symptom reporting between physicians and parents varied from poor to moderate. The absence of agreement for specific exercise-induced respiratory symptom characteristics was mainly due to parental reporting of symptoms that were not mentioned in the physician letter; only in a few instances did the outpatient clinic letter include symptoms that were not reported in the parental questionnaire. Two studies that investigated agreement between physician documentation and standardised parent reporting of paediatric respiratory symptoms, but which were not specifically focused on exercise-induced respiratory symptoms, similarly found a poor-to-fair agreement. A study using population-based data from the Dutch Generation R study found that parents more often reported wheezing than physicians (36% versus 20%, $\kappa = 0.36$), in line with our results [30]. Additionally, the WHISTLER Birth Cohort (1007 children, age 5 years) reported a $\kappa = 0.07$ for recent wheezing and a $\kappa = 0.12$ for ever wheezing [31].

There are small differences in how single data variables were characterised in the outpatient clinic letter (physician) versus the parental questionnaire (table 1), most notably for the wording accompanying the timing of exercise-induced respiratory symptom onset. It follows that the kappa agreement could have been influenced by misclassification of extracted data on the part of the authors. Misclassification may also have been introduced by parental interpretation of their child's symptoms while filling in the standardised questionnaire and selecting among dichotomous response options ("Yes" or "No"). Respiratory symptoms, particularly "wheezing", can be difficult for parents to distinguish from physiological "noisy breathing" that accompanies exercise [32]. However this misclassification could arguably have equally affected symptom history noted by physicians, which was also based on parental reports. Missing data from physician letters or parental questionnaires may have also affected kappa agreement, with potential for either weaker or stronger results.

The analysis of depersonalised health data from a coordinated data infrastructure will be increasingly important for enhancing the understanding, management and prevention of disease [16]. In Switzerland, several projects within the Swiss Personalised Health Network aim to standardise routine healthcare data and make it more readily available for research [17, 18]. Enhanced symptom documentation could improve the capacity for paediatric respiratory research by bolstering the comprehensiveness of the Swiss data infrastructure. One way to accomplish this would be through inclusion of a standardised checklist of exercise-induced respiratory symptom characteristics, to be jointly completed by parents and patients, and stored in the coordinated data infrastructure. Our study suggests that questionnaires remain a vital source of information in paediatric research studies and can effectively complement physician documentation, particularly as it pertains to detailed recording of symptom characteristics. Questionnaires should be carefully validated with a diverse population to ensure correct interpretation of terminology, for example what is meant by "wheezing", and generate reproducible data, thus minimising the risk of misinterpretation of symptoms. Ideally, doctors should also review the questionnaire jointly with the parent(s) and child before it is stored in the medical record to validate the answers and further ensure the quality of health repository data. This offers a solution that does not oblige paediatric pulmonologists to document exercise-induced respiratory symptoms with lengthy symptom checklists or preformulated templates, which would elongate and complicate outpatient clinic letters and likely not enhance physician communication.

This study is strengthened by the real-world, observational design of the Swiss Paediatric Airway Cohort, the relatively large size of this cohort and the inclusion of children from different paediatric respiratory outpatient clinics in Switzerland. Another strength is the inclusion of children with exercise-induced respiratory symptoms of different aetiologies, thus allowing a comprehensive analysis of exercise-induced respiratory symptom documentation which includes both asthma and rarer diagnoses. A limitation of this study is that it only represents children referred to participating paediatric respiratory outpatient clinics in the German-language region of Switzerland. We, however, do not have reason to suspect that exercise-induced respiratory symptom documentation would differ systematically in the other Swiss regions.

Conclusion

Characteristics of paediatric exercise-induced respiratory symptoms are documented differently by physicians and parents, with a generally low level of agreement when comparing the outpatient physician letter with a standardised parent questionnaire. Standardised, parent-completed questionnaires should be viewed as an important complement to physician letters when considering the comprehensiveness of the paediatric health data infrastructure. Since comprehensive documentation of paediatric respiratory symptoms is important when analysing data exported from coordinated data infrastructures, a structured way of digitally documenting symptoms could enhance the usability of routine healthcare data in future paediatric exercise-induced respiratory symptom research

Data access

The dataset supporting this analysis is not publicly available. The participants of this study did not give written consent for their data to be published in an open data repository. Upon reasonable request, the deidentified data that generated the findings of this study may be shared by the corresponding author (CK).

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. *FS* reports financial support from Novartis Pharma, Vertex Pharmaceuticals, and non-financial support from Chiesi Pharmaceuticals, Amgen Inc. outside the submitted work. No other potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix

Supplement 1: Analytical code used for analysis of manuscript data. STATA version 14 was used for all analyses.

*all analysis done on baseline data (event==2)

*######################

*table 2: characteristics

```
sum age_bl_q if event==2

tab gender if event==2

sum bmi_zscore1 if event==2

tab sport_leisure_yn if event==2

tab swiss_child if event==2

tab edu_m if event==2

tab edu_f if event==2

tab smoke_m if event==2

tab smoke_f if event==2

tab wheeze_lyr if event==2, m

tab wheeze_freq if event==2, m

tab exer_breath_yn if event==2

tab diagnosis_reduced_all if event==2, m
```

*Figure 1

* information reported by physicians in clinical letter by diagnosis groups (diagnosis_reduced_all)

```
tab letter_symptoms diagnosis_reduced_all if event==2, col m

tab eis_sport_types___10 diagnosis_reduced_all if event==2, col m
```

tab letter_tightness diagnosis_reduced_all if event==2, col m

tab eis_phase diagnosis_reduced_all if event==2, col m

tab letter_symp_begin diagnosis_reduced_all if event==2, col m

tab eis_medi_mentioned diagnosis_reduced_all if event==2, col m

tab eis_medi_effect_mentioned diagnosis_reduced_all if event==2, col

*Table 3: description of information documented by physicians in letter and symptoms reported by parents in questionnaire and agreement

tab letter_wheeze_comb if event==2 & letter_symp_yn==1 & eis_both==1, m

tab exer_wheeze if event==2 & eis_both==1, m

tab letter_wheeze_comb exer_wheeze if event==2 & eis_both==1, cell m

kap letter_wheeze_comb exer_wheeze if event==2 & eis_both==1 & letter_symp_yn==1

tab letter_cough if event==2 & eis_both==1, m

tab exer_cough if event==2 & eis_both==1, m

tab letter_cough exer_cough if event==2 & eis_both==1, cell m

kap letter_cough exer_cough if event==2 & eis_both==1

tab letter_dyspnoe if event==2 & eis_both==1, m

tab exer_dyspnoe if event==2 & eis_both==1, m

tab letter_dyspnoe exer_dyspnoe if event==2 & eis_both==1, cell m

tab letter_tingle if event==2 & eis_both==1, m

tab exer_tingle_yn if event==2 & eis_both==1, m

tab letter_tingle exer_tingle_yn if event==2 & eis_both==1, cell m

tab exer_other_spec if event==2 & eis_both==1, m

```
tab letter_dizzy if event==2 & eis_both==1

tab letter_fast_tired if event==2 & eis_both==1


tab letter_sigh if event==2 & eis_both==1

tab letter_other if event==2 & eis_both==1

tab letter_unspecified if event==2 & eis_both==1


tab letter_dizzy exer_other_spec if event==2 & eis_both==1, row m

tab letter_fast_tired exer_other_spec if event==2 & eis_both==1, row m



tab letter_trig_run if event==2 & eis_both==1 &eis_sport_types___10!=1

tab exer_run_comb if event==2 & eis_both==1 &eis_sport_types___10!=1

tab letter_trig_run exer_run_comb if event==2 & eis_both==1 & eis_sport_types___10!=1, cell m


tab eis_sport_types___7 if event==2 & eis_both==1 &eis_sport_types___10!=1

tab exer_cycle_cat if event==2 & eis_both==1 &eis_sport_types___10!=1

tab eis_sport_types___7 exer_cycle_cat if event==2 & eis_both==1 & eis_sport_types___10!=1, cell m


tab eis_sport_types___2 if event==2 & eis_both==1 &eis_sport_types___10!=1

tab exer_sport_cat if event==2 & eis_both==1 &eis_sport_types___10!=1

tab eis_sport_types___2 exer_sport_cat if event==2 & eis_both==1 & eis_sport_types___10!=1, cell m


tab eis_sport_types___8 if event==2 & eis_both==1 &eis_sport_types___10!=1

tab exer_swim_cat if event==2 & eis_both==1 &eis_sport_types___10!=1

tab eis_sport_types___8 exer_swim_cat if event==2 & eis_both==1 & eis_sport_types___10!=1, cell m
```

```
tab letter_tightness if event==2 & eis_both==1 & exer_tightness !=.

tab exer_tightness if event==2 & eis_both==1 & letter_tightness!=.

tab letter_tightness exer_tightness if event==2 & letter_tightness!=. & exer_tightness!=., cell m

kappa letter_tightness exer_tightness if event==2 & eis_both==1 & exer_tightness!=. &
letter_tightness!=.


replace eis_phase = 2 if letter_wheeze == 1

gen eis_phase_mentioned = 1 if eis_phase == 1 | eis_phase ==2 | eis_phase==3

tab eis_phase if event==2 & eis_both==1 & eis_phase_mentioned==1 & exer_moment!=.

tab exer_moment if event==2 & eis_both==1 & eis_phase_mentioned==1 & exer_moment!=.

tab eis_phase exer_moment if event==2 & eis_both==1 & eis_phase_mentioned==1 & exer_moment!=.,
cell m

kappa eis_phase exer_moment if event==2 & eis_both==1 & eis_phase !=. & exer_moment!=.


gen letter_symp_begin_mentioned = 1 if letter_symp_begin==1 | letter_symp_begin==2 |
letter_symp_begin==3

gen letter_symp_begin_dicho = 1 if letter_symp_begin==1 | letter_symp_begin==2

replace letter_symp_begin_dicho=2 if letter_symp_begin==3

tab letter_symp_begin_dicho if event==2 & eis_both==1 & letter_symp_begin_mentioned==1 &
exer_start_comb!=.

tab exer_start_comb if event==2 & eis_both==1 & letter_symp_begin_mentioned==1 &
exer_start_comb!=.

tab letter_symp_begin_dicho exer_start_comb if event==2 & eis_both==1 &
letter_symp_begin_mentioned==1 & exer_start_comb!=., cell m


tab eis_medi if event==2 & eis_both==1 & eis_medi_mentioned==1 & exer_spray_yn!=.

tab exer_spray_yn if event==2 & eis_both==1 & eis_medi_mentioned==1 & exer_spray_yn!=.

tab eis_medi exer_spray_yn if event==2 & eis_both==1 & eis_medi_mentioned==1 & exer_spray_yn!=.,
cell m
```

```
gen eis_medi_effect_dicho = 1 if eis_medi_effect==1

replace eis_medi_effect_dicho = 2 if eis_medi_effect==2 | eis_medi_effect==3

gen exer_spray_effect_dicho = 1 if exer_spray_effect_comb==1

replace exer_spray_effect_dicho=2 if exer_spray_effect_comb==2 | exer_spray_effect_comb==3


gen eis_medi_effect1 = eis_medi_effect

tab eis_medi_effect1 if event==2 & letter_symp_yn==1 & eis_medi==1 & exer_spray_effect_comb!=. & eis_medi_effect1!=.

tab exer_spray_effect_comb if event==2 & letter_symp_yn==1 & eis_medi==1 & exer_spray_effect_comb!=. & eis_medi_effect1!=.

kappa eis_medi_effect1 exer_spray_effect_comb if event==2 & letter_symp_yn==1 & eis_medi==1 & exer_spray_effect_comb!=. & eis_medi_effect1!=.
```

*Supplement 2 table

```
tab2 letter_tightness exer_tightness if event==2 & letter_tightness!=. & exer_tightness!=., cell m


tab2 eis_phase exer_moment if event==2 & eis_both==1 & eis_phase_mentioned==1 & exer_moment!=., cell m


tab2 exer_spray_effect_comb eis_medi_effect1 if event==2 & letter_symp_yn==1 & eis_medi==1 & exer_spray_effect_comb!=. & eis_medi_effect1!=., col
```

Supplement 2: Agreement between physician-documented and parent-reported EIS (N=193)

Symptom localisation (N=73)

		Physician documented			Kappa
		Chest	**Throat**	**Chest and throat**	0.36
Parent reported	**Chest**	31 (42)	1 (1)	8 (11)	
	Throat	8 (11)	10 (14)	8 (11)	
	Chest and throat	2 (3)	1 (1)	4 (5)	

Respiratory phase (N=94)

		Physician documented			Kappa
		Inspiration	**Expiration**	**Inspiration & expiration**	0.13
Parent reported	**Inspiration**	26 (28)	2 (2)	19 (20)	
	Expiration	16 (17)	3 (3)	18 (19)	
	Inspiration & expiration	47 (50)	0	5 (5)	

Effect of bronchodilator (N=76)

		Physician documented			Kappa
		EIS disappears	**EIS reduced**	**No difference**	0.27
Parent reported	**EIS disappears**	7 (30)	8 (28)	2 (8)	
	EIS reduced	14 (61)	15 (52)	13 (54)	
	No difference	2 (9)	6 (21)	9 (38)	

We analysed agreement if the characteristic in question was mentioned both in the physician's outpatient clinical letter and the parental questionnaire, thus characteristics that were missing in both documents were excluded from this analysis. The number given in parenthesis represents the percentage.

Abbreviation: EIS = exercise-induced respiratory symptoms