ESCOLA
SUPERIOR
DE SAÚDE
POLITÉCNICO
DO PORTO

P.PORTO

M

MESTRADO
FISIOTERAPIA CARDIORRESPIRATÓRIA

Therapeutic possibilities for central sleep apnoea syndrome in the paediatric age group: Scopping Review

Ellidynaary Matias da Silva

07/**2024**

ESCOLA
SUPERIOR
DE SAÚDE

Therapeutic possibilities for central sleep apnoea syndrome in the paediatric age group: Scoping Review

Autora

Ellidynaary Matias Da Silva

Orientadoras

Professora Doutora Ana Alexandrino / Escola Superior de Saúde, Politécnico do Porto

Mestre Natália Azevedo / Escola Superior de Saúde, Politécnico do Porto

Dissertação apresentada(o) para cumprimento dos requisitos necessários à obtenção do grau de Mestre em **Fisioterapia Cardiorrespiratória** pela Escola Superior de Saúde do Instituto Politécnico do Porto.

Resumo

Introdução: A apneia central do sono (ACS) é um dos distúrbios respiratórios do sono mais comum em idade pediátrica, e é considerada uma patologia complexa que dificilmente é o diagnóstico primário. Quando não deviamente tratada torna-se um problema de saúde pública, podendo desencadear o desenvolvimento ou agravamento de uma série de doenças sistémicas com repercussões negativas no desenvolvimento e qualidade de vida das crianças.

Objetivo: Mapear as intervenções terapêuticas mais frequentemente referidas na literatura, incluindo aquelas que estão no âmbito da atuação do fisioterapeuta, para o tratamento da ACS em idade pediátrica e em diferentes contextos.

Metodologia: Esta Scoping Review foi elaborada de acordo com as recomendações do Joanna Briggs Institute (JBI) e Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review (PRISMA-ScR). Realizou-se pesquisa de estudos na faixa etária de 0 a 18 anos, em tratamento para ACS, em contexto de internamento, ambulatório ou domicílio. Foram considerados estudos escritos em inglês ou em português, publicados entre os anos de 2012 a 2024.

Resultados: Dos 4.665 estudos inicialmente identificados, foram selecionados 10 artigos, de acordo com os critérios de inclusão e exclusão, a maior parte do tipo observacional ou Coorte retrospetivo. Os resultados mostram um uso mais frequente da cirurgia otorrinolaringológica (30,76%), seguida pela terapia por Positive Airway Pressure (PAP) (26,92%), maioritariamente no contexto hospitalar, associado ou não com contexto ambulatório e domiciliário. O fisioterapeuta colaborou em 42,30% das intervenções terapêuticas incluídas nos estudos, maioritariamente na terapia PAP e oxigenoterapia.

Conclusão: As cirurgias otorrinolaringológicas e a PAP foram as intervenções terapêuticas mais frequentes no tratamento da ACS na criança, maioritariamente em contexto hospitalar. O fisioterapeuta tem um papel importante na adaptação e acompanhamento dos pacientes sob PAP e na oxigenoterapia.

Palavras-chave: Apneia central do sono; Ventilação invasiva, Positive Airway Pressure, Ventilação não invasiva; Fisioterapia respiratória; Cirurgia; Tratamento farmacológico; Oxigenoterapia; Criança; Pediatria.

Abstract

Introduction: Central sleep apnea (CSA) is one of the most common respiratory sleep disorders in the pediatric population and is considered a complex pathology that is rarely the primary diagnosis. When not treated properly, it becomes a public health problem, potentially triggering the development or worsening of a series of systemic diseases with negative repercussions on the development and quality of life of children.

Objective: To map the most frequently referred to therapeutic interventions in the literature, including those within the scope of physiotherapy practice, for the treatment of pediatric central sleep apnea in different contexts.

Methodology: This Scoping Review was prepared according to the recommendations of the Joanna Briggs Institute (JBI) and the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review (PRISMA-ScR). A search for studies was conducted in the age group of 0 to 18 years, in treatment for CSA, in the context of hospitalization, outpatient or home care. Studies written in English or Portuguese, published between 2012 and 2024.

Results: Of the 4,665 studies initially identified, 10 articles were selected, according to the inclusion and exclusion criteria, most of them observational or Coorte and retrospective. The results show a more frequent use of otolaryngological surgery (30.76%), followed by Positive Airway Pressure (PAP) therapy (26.92%), mainly in the hospital setting, associated or not with outpatient and home care settings. The physiotherapist collaborated in 42.30% of the prescribed therapeutic interventions, mainly in PAP therapy and oxygen therapy.

Conclusion: Otolaryngological surgeries and Positive Airway Pressure were the most frequent therapeutic interventions in the treatment of pediatric central sleep apnea, mainly in the hospital setting. The physiotherapist has an important role in the adaptation and monitoring of patients on Positive Airway Pressure and oxygen therapy.

Keywords: Central sleep apnea; Invasive ventilation, Positive Airway Pressure, Non-invasive ventilation; Respiratory physiotherapy; Surgery; Pharmacological treatment; Oxygen therapy; Child; Pediatrics

Table of Contents

List of Abbreviations and Acronyms

AASM	American Academy of Sleep Medicine
ASV	Adaptive Servo-Ventilation
AHI	Apnoea-Hypopnoea Index
BIPAP	Bi-level Positive Airway Pressure
CAI	Central Apnoea Index
C-AHI	Central Apnoea-Hypopnoea Index
CO2	Carbon Dioxide
CPAP	Continuous Positive Airway Pressure
CNS	Central Nervous System
CSA	Central Sleep Apnoea
ICSA	Idiopathic Central Sleep Apnoea
CSB	Cheyne-Stokes breathing
ICSD-3	International Classification of Sleep Disorders – Third Edition
IPP	Instituto Politécnico do Porto
IPPV	Invasive Positive Pressure Ventilation
NIS	National Institute of Statistics
NIV	Non-Invasive Ventilation
OSA	Obstructive Sleep Apnoea
PaCO2	Partial Pressure of Carbon Dioxide in Arterial Blood
PAP	Positive Airway Pressure
PCC	Population, Concept e Context
PSG	Polysomnography
SBD	Sleep Breathing Disorders
SpO2	Peripheral Oxygen Saturation
UAW	Upper Airways

1. Introduction

Among the known sleep breathing disorders (SBD), obstructive sleep apnoea (OSA) and central sleep apnoea (CSA) are considered the most common in paediatric age (Sateia 2014). Despite being less mentioned in the literature compared to OSA, CSA is a complex pathology that is rarely the primary diagnosis as an isolated condition. Generally, CSA is associated with other comorbidities, thus contributing to the onset and exacerbation of cardiac and metabolic disorders (Baillieul et al. 2019).

Central sleep apnoea (CSA) occurs when the partial pressure levels of carbon dioxide in arterial blood (PaCO2) fall below the apnoeic threshold, and the nervous system cannot trigger a new respiratory cycle (Wheeler et al. 2021). There is a transient interruption of the central nervous system (CNS) command to the respiratory muscles, ceasing thoraco-abdominal movements and oronasal airflow (Balbani et al. 2005). In the paediatric age group, it usually lasts 20 seconds or more and is associated with a reduction in peripheral oxygen saturation (SpO2) of 3% or more relative to baseline (Felix et al. 2016).

According to the International Classification of Sleep Disorders – Third Edition (ICSD-3), children under 13 years old are diagnosed with CSA when the central apnoea-hypopnoea index (C-AHI) per hour of sleep or recording is greater than one central apnoea and/or central hypopnoea event per hour of sleep, subsequently classified as mild, moderate, and severe. In children over 13 years old, they are assessed by the same criteria as adults, with a C-AHI > 5 events/h (Sateia 2014).

The diagnostic test considered as the reference by the American Academy of Pediatrics to detect sleep-related breathing disorders is nocturnal polysomnography (PSG) in a sleep laboratory, PSG type I (Pires et al. 2019). The signals detected by PSG I can classify CSA into levels of severity: mild (C-AHI between 1-4.9/h), moderate (C-AHI between 5-10/h), or severe (C-AHI greater than 10/h). These indices are considered clinically significant indicators, requiring further investigation of their aetiology (Gerdung et al. 2022; Sateia 2014).

In the literature, some treatments considered effective are described: surgical, pharmacological, Positive Airway Pressure (PAP) therapy, and oxygen therapy. Surgeries can occur at the brainstem or upper airways (UAW) level. Drugs are selected according to the patient's underlying pathology or condition, generally to re-establish the proper ventilatory pattern and increase ventilation. PAP is chosen when there is a need to maintain UAW patency or to assist the respiratory drive, while oxygen therapy is usually used in newborns or infants (Xiao et al. 2022).

Treatment plans require a multidisciplinary team with professionals specialized in the described approaches and in-depth studies with proven applicability to ensure personalized and effective therapy (Madan Jha 2023).

Scientific evidence on the diagnosis, therapy, and follow-up of CSA in the paediatric population is scarce. CSA has an incidence of 4-6% and is considered rare in children over 12 months old (McLaren et al. 2019). This prevalence of CSA may be underestimated as most diagnosed patients are asymptomatic, reflecting a lack of data, especially in those over one year of age, making early diagnosis and treatment difficult (Felix et al. 2016).

Addressing the present topic becomes relevant due to the growing trend in the number of cases diagnosed with SBD and consequently CSA. In the absence of timely and correct diagnosis and treatment, CSA becomes a public health problem, potentially triggering the development or worsening of a series of systemic diseases with negative repercussions on children's development and quality of life (Madan Jha 2023).

Additionally, there are no guidelines to be followed for treating children diagnosed with CSA due to the lack of literature on this topic, highlighting the need for an anthology that encompasses published studies. This work aims to identify the knowledge described in the scientific literature to organise the information found and compile the main therapies used when diagnosing CSA in children, relevant to physiotherapist intervention.

The objective of this study was to identify and map the most frequently referred therapeutic interventions in the literature, including those within the scope of physiotherapy practice for the treatment of CSA in paediatric age (0 to 18 years) in different contexts (hospital, outpatient, and home). This overview led to the following guiding question: What are the most frequent therapeutic interventions in the literature for the treatment of CSA in paediatric age in different contexts? Among them, which ones cover the training and knowledge of the physiotherapist?

2. Methods

2.1. Type of Study

This is a Scoping Review study according to the review method proposed by the Joanna Briggs Institute (JBI) and the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review (PRISMA-ScR). This method allows mapping the main concepts, clarifying research areas, and identifying knowledge gaps (Arksey & O'Malley 2005; Peters et al. 2015). The protocol for the Scoping Review design was duly registered and publicly declared on the Open Science Framework, generating the following DOI: 10.17605/OSF.IO/PW8RZ

2.2. Sources of Information and Search Strategy

For selecting eligible documents for this review, a preliminary search was conducted to identify the most used keywords and terms in titles for inclusion in the final strategy. The guiding question was constituted based on the Population Concept and Context (PCC) strategy, representing an acronym for population, concept, and context (Arksey & O'Malley 2005; Peters et al. 2015).

Studies evaluating children and adolescents diagnosed with CSA and undergoing treatment in the following databases were selected: Pubmed Central, Clinical-trials.gov, Scopus, Web of Science, and Cochrane Library. Study selection occurred according to the Medical Subject Headings (MeSH) of the following words: "Sleep Apnea Central", "Child", "Therapeutic", "Treatment", "Therapeutic Approaches", "Surgery", "Respiratory Physiotherapy", "Oxygen Inhalation Therapy", "Drug therapy", "Positive Airway Pressure", and "Non-Invasive Ventilation" in association with the Boolean operator AND through intersections and search strategies as detailed in Appendix I.

2.3. Eligibility Criteria

Inclusion and exclusion criteria were defined based on the PCC concept for better selection of results and approximation of the answer to the guiding question.

A search was conducted for studies in the paediatric age group of 0 to 18 years (population) as established by the Children's and Adolescents' Notebook in Portugal from the National Institute of Statistics (INE) (CARRILHO 2015), undergoing treatment for CSA in hospitalisation, outpatient, or home settings (context) to understand which treatments were most frequently used and most effective when diagnosing CSA (concept).

Studies written in English or Portuguese and published between 2012 and 2024, available in open-access or through partnerships with the Polytechnic Institute of Porto (IPP), were considered. The selection of these criteria stems from the scarcity of studies on the subject in question.

In the first phase, articles were evaluated according to their title and abstract to determine their eligibility. During selection, studies were excluded if identified as simple or expanded abstracts published in proceedings of scientific events, studies with a review methodology, as they do not gather results with a direct approach to patients, and other articles that did not answer the previously defined guiding question. Exclusion criteria allow focusing efforts on selecting scientific articles that demonstrate evidence with direct data and results on the target audience. All these criteria are described in Table 1.

Table 1 – Study eligibility criteria

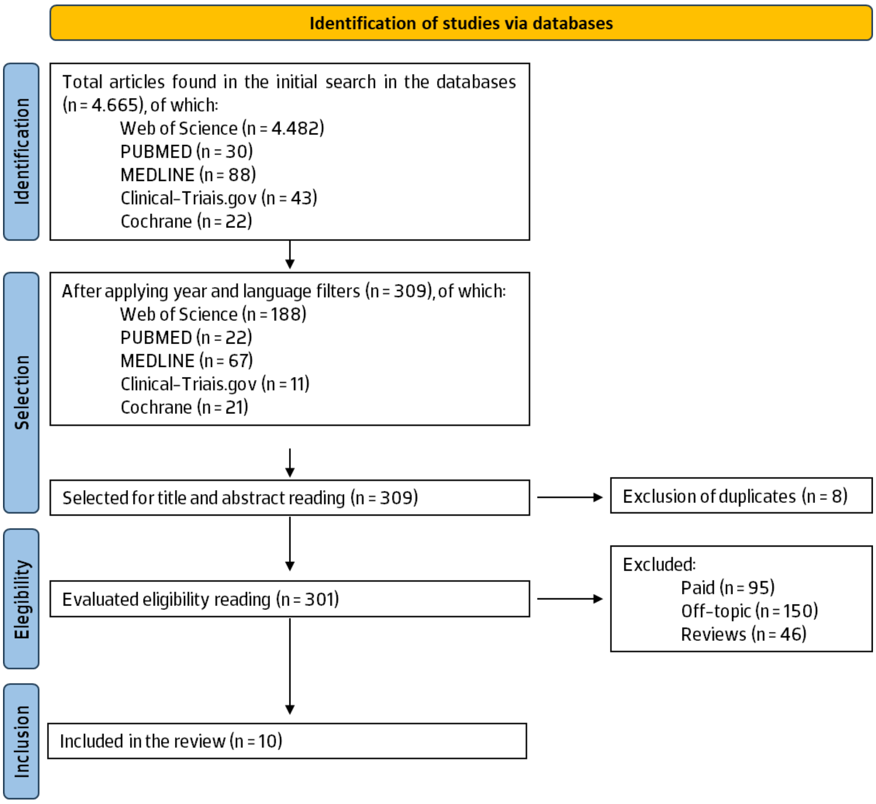
Description	Inclusion Criteria	Exclusion Criteria
STUDY DESIGN	Quantitative study designs: Randomised Clinical Trials (RCTs), Cohort, and Cross-sectional.	Systematic reviews and case reports.
LANGUAGE	Articles in Portuguese or English.	Articles for which the full text was not accessible in the selected languages.
PUBLICATION DATE	Between 2012 and 2024	Articles before 2012.
POPULATION	Children and adolescents aged 0 to 18 years diagnosed with CSA.	Adults and children without a medical diagnosis of CSA.
CONTEXT	Patients undergoing treatment for CSA in hospitalisation, outpatient, or home settings.	Children without an established diagnosis or on watchful waiting.
CONCEPT	Treatments most frequently used and with demonstrated results, including the scope of the physiotherapist's practice.	Studies whose objective was not directly related to the guiding question.

Legend: CSA (Central Sleep Apnoea); RCTs (Randomised Clinical Trials)

It is important to mention that the same keywords were also searched in Portuguese in the Health Sciences Descriptors (DeCS). However, the descriptors in Portuguese did not reveal any valid results for this review.

The updated methodological recommendations of the Joanna Briggs Institute (JBI), aligned with the strategy of the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review (PRISMA-ScR), were used to guide the entire process of constructing and writing this review. The initial screening was performed by the author. The second selection was carried out by an independent reviewer, conducting the same search process described above, followed by the evaluation of titles and abstracts of all studies selected through search strategies and selection. Subsequently, the full texts of studies for which there was doubt regarding their inclusion or exclusion were read. This entire process is described and exemplified in a flowchart (Figure 1).

Figure 1 – Literature selection flowchart.



The collected and extracted data were entered into a table in Microsoft Excel format (version 14.0.460, Microsoft Corporation 2010). The table described study characteristics that helped in organisation and categorisation. These data are presented throughout this review in Tables 2, 3, and 4.

3. Results

Thus, a total of 10 documents were selected to compose this Scoping Review. For better understanding and visualisation of the selected studies, the findings were categorised into tables according to publication year, author, study type, level of evidence according to the Oxford Centre for Evidence-Based Medicine (2009), analysed period, and sample size (Table 2), and results grouped with PCC criteria (Table 3).

Table 2 – Studies according to publication year, author, study type, level of evidence, analysed period, and sample size.

STUDY	AUTHOR	STUDY TYPE	LEVEL OF EVIDENCE	ANALYSED PERIOD	SAMPLE SIZE
1	(Ghirardo et al., 2021)	Observational, Retrospective	4	6 years	N=95
2	(Gerdung et al., 2022)	Longitudina, Retrospective, Cohort	3b	4 years	N=165
3	(Felix et al., 2016)	Observational, Retrospective	4	1 year and 8 months	N=18
4	(Al-Saleh et al., 2017)	Observational, Retrospective	4	5 years	N=274
5	(Waich et al., 2022)	Cross-sectional, Descriptive Epidemiological, Observational	4	5 years	N=9.737
6	(Gurbani et al., 2017)	Retrospective, Cohort	3b	10 years	N=14
7	(Xiao et al., 2022)	Observational, Retrospective	4	10 years	N=18
8	(Boudewyns et al., 2016)	Cohort, Retrospective	3b	5 years	N=90
9	(Del-Río Camacho et al., 2019)	Cohort, Retrospective	3b	10 years	N=66
10	(Baldassari et al., 2012)	Cohort, Retrospective	3b	10 years	N=15

Legend: N = sample number.

Table 3 – Grouping of results by population, concept, and context

STUDY	AGE RANGE OF SAMPLE	THERAPEUTIC INTERVENTION ANALYSED							TREATMENT CONTEXT		
		Surgeries		Oxygen Therapy	Drugs		*¹PAP				
		*²UAW	*³NEURO		CAFFEINE	*4ACETA	*5IPPV	*6NIV	*7HOSP	*8OUTP	HOME
1	1 month to 18 years	✓	✓	✓	✓	✓		✓	✓	✓	✓
2	0 to 18 years							✓		✓	✓
3	1 to 18 years		✓			✓		✓	✓	✓	✓
4	Mean age (SD) 10,52 (5,11) years.						✓	✓	✓	✓	✓
5	0 to 17 years	✓						✓	✓		✓
6	0 to 17 years			✓	✓			✓		✓	✓
7	0 to 12 years			✓	✓			✓	✓		✓
8	1 to 6 years	✓							✓		
9	1 to 14 years	✓							✓		
10	1 to 16 years	✓							✓		

Legend: *¹PAP (Positive Airway Pressure); *²UAW (Upper Airway); *³NEURO (Neurosurgery); *4ACETA (Acetazolamide); *5IPPV (Invasive Positive Pressure Ventilation); *6NIV (Non-Invasive Ventilation); *7IH (Inpatient); *8AMB (Outpatient); *9Home.

All of the studies were retrospective (Ghirardo et al., 2021; Gerdung et al., 2022; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Gurbani et al., 2017; Xiao et al., 2022; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al., 2012), 2012), 50 per cent of which were observational studies aimed at describing the existence or not of a relationship between therapeutic interventions and the results of the intervention, and 50 per cent cohort studies aimed at investigating the cause-effect relationship in relation to therapeutic interventions in groups of children with CSA.

In general, the level of evidence of these studies is considered to be of low quality, with a weak degree of recommendation overall (Oxford Centre for Evidence-Based Medicine, 2009).

The majority of the studies considered an analysis period of 10 years (40%) (Gurbani et al., 2017; Xiao et al., 2022; Del-Río Camacho et al., 2019; Baldassari et al., 2012) followed by 5 years (30%) (Al-Saleh et al., 2017; Waich et al., 2022; Boudewyns et al., 2016), and finally 6 years (Ghirardo et al., 2021), 4 years (Gerdung et al., 2022) and 1 year and 8 months (Felix et al., 2016), each with 10%. This information indicates that the results obtained had data from several years, allowing a comparison between these studies and generating broad results.

The 10 articles were published in English in different countries, including: Canada (30 per cent), France (20 per cent), Colombia (10 per cent), Spain (10 per cent), Belgium (10 per cent), the USA (10 per cent), and one study that took place simultaneously in therapeutic units in the USA and Belgium (10 per cent). The age range was from 0 to 18 years, covering and analysing all age groups.

The sample size of the studies ranged from 15 to 9,737 children and adolescents diagnosed with CSA with mild, moderate and severe C-AHI, with a higher frequency of cases in males.

Only the study by Xiao et al. (2022) analysed the sample at the beginning of early childhood, babies aged between 0 and 12 months who had a median gestational age of 38 weeks. Of these, there was only one case considered severe with an C-AHI of 100.5 events/hour and a minimum SpO2 of 69%.

With regard to the most common intervention contexts, 8 of the 10 selected articles were applied in a hospital setting (Ghirardo et al., 2021; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Xiao et al., 2022; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al, 2012), 5 in outpatient settings (Ghirardo et al., 2021; Gerdung et al., 2022; Felix et al., 2016; Al-Saleh et al., 2017; Gurbani et al., 2017) and 7 in a home setting (Ghirardo et al., 2021; Gerdung et al., 2022; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Gurbani et al., 2017; Xiao et al., 2022). It was noted that most of these studies were carried out following participants from inpatient, outpatient and home care (three articles) or only in inpatient care (three articles).

The main pathologies associated with CSA diagnosis cited were: OSA, prematurity, hydrocephalus, Chiari malformation, Robin Lange syndrome, Down syndrome, Prader Willi syndrome, Asperger syndrome, periodic breathing, encephalopathy, mucopolysaccharidosis, achondroplasia, epilepsy, brain tumour, congenital heart disease, asthma, ganglioglioma, lung and musculoskeletal/neuromuscular diseases, bipolar disorder, attention deficit hyperactivity disorder. Of these, Chiari malformation and periodic breathing were the most frequent in children diagnosed with CSA.

Comparing the therapeutic interventions used between the studies, there was evidence of treatments involving: neurosurgery, otorhinolaryngological surgery, oxygen therapy, caffeine, acetazolamide, PAP (CPAP, BIPAP, Adaptive Servo-Ventilation (ASV) and IPPV (invasive positive pressure ventilation). The most common treatment in the studies was ENT surgery (30.76%), followed by PAP (26.92%). PAP was used in different age groups in children being treated with a diagnosis of CSA only or associated with some comorbidity, especially CNS disorders. Table 4 shows the frequencies of treatments applied to children with CSA in the studies consulted.

Table 4 – Therapeutic interventions described by the authors.

THERAPEUTIC INTERVENTIONS DESCRIBED	Nº OF QUOTATIONS	%
Neurosurgery	2	7,69%
ENT Surgery	8	30,76%
Oxygen therapy	3	11,53%
Caffeine	2	7,69%
AcetazolamidE	3	11,53%
PAP (IPPV)	1	3,84%
PAP (VNI) CPAP, BIPAP, ASV	7	26,92%
	TOTAL	100%

Legend: PAP (Positive Airway Pressure); IPPV (invasive positive pressure ventilation); NIV (non-invasive ventilation); CPAP (Continuous Positive Airway Pressure); BIPAP (Bi-level Positive Airway Pressure); ASV (Adaptive Servo-Ventilation).

It is clear that most of the studies implemented more than one therapeutic intervention, so the number cited cannot be equated with the total number of studies, but this type of organisation makes it possible to understand which treatment was most common among the various therapeutic options.

Table 5 shows the results of the interventions presented in each study and the strategies covering physiotherapist training and knowledge.

Table 5 – Results demonstrated in the studies and verification of intervention strategies covering physiotherapist training and knowledge.

STUDY	RESULT / PROGNOSIS	PHYSIOTHERAPIST INTERVENTION
1	CPAP (Continuous Positive Airway Pressure) was the treatment of choice for two patients, one with an increased C-AHI and the other with a good response to treatment. Watchful waiting was carried out on 22 patients < 1 year old, where spontaneous improvement was seen over time in 20 patients. The other treatments (UAW surgery or neurosurgery, nocturnal oxygen therapy, non-invasive ventilation) were effective in carefully selected patients according to the type of CSA presented and taking into account associated comorbidities.	Oxygen therapy / PAP (CPAP)
2	CPAP was recommended for 76.9 per cent of the sample and Bi-level Positive Airway Pressure (BIPAP) was administered to 16.2 per cent of the children. Most of the study subjects had significantly improved C-AHI, SpO2 and ventilation with PAP treatment (CPAP / BIPAP).	PAP (CPAP / BIPAP)
3	Acetazolamide was used in two patients with Prader-Willi syndrome, but only in one patient was there a 50 per cent reduction in the AHI. All the patients treated with PAP (CPAP / ASV) had a completely corrected CSA.	PAP (CPAP/ASV)
4	The study analysed the change in ventilatory mode and dosage of 274 patients indicated to start PAP therapy as a treatment for SBD. Therapeutic efficacy was considered to be the recording of minimal central apnoeas and hypopnoeas (i.e. AHI < 1.0 events/h). CPAP was recommended for 83 patients, BIPAP for 166 patients and IPPV (Invasive Positive Pressure Ventilation) for 25 patients.	PAP (CPAP / BIPAP/ IPPV)
5	There was no intervention of any kind in children under 1 year of age. It was also found that over the years there has been a reduction in the number of UAW surgeries and an increase in the use of PAP therapies.	PAP
6	In this study, supplementary oxygen was administered in 3 out of 14 patients, BIPAP support in one patient and 7 out of 14 patients were treated with acetazolamide. Three patients had no intervention of any kind, just strict clinical monitoring with repeated sleep studies. All the patients responded to the	Oxygen therapy / PAP (BIPAP)

	treatment administered, showing a reduction in the C-AHI. Supplementary oxygen therapy is recommended as first-line treatment for the diagnosis of CSA in children who do not present with hypoventilation.	
7	Most of the infants in this cohort study were treated with supplementary oxygen therapy, which helped to stabilise their breathing pattern. One of the infants presented with severe CSA with an C-AHI of 100.5 events/hour and a minimum SpO_2 of 69%, verified on PSG. He was first submitted to the use of supplementary oxygen, but developed a hypercapnic response. He was subsequently discharged with an indication for home PAP therapy. A further 28 per cent of the sample, based on individual clinical preference, were prescribed caffeine in addition to supplementary oxygen. There was a significant improvement in the C-AHI in all the babies.	Oxygen therapy / PAP (CPAP)
8	None of the children treated surgically had C-AHI ≥5/hour after surgery. Adenotonsillectomy was the UAW surgery that showed a significant reduction in the number of central apnoeas and a resolution of CSA.	No physiotherapist intervention
9	After UAW surgery, 43.93 per cent of the sample had their C-AHI reduced to less than 50 per cent of the baseline values identified in the preoperative PSG.	No physiotherapist intervention
10	There was a significant improvement in C-AHI after adenotonsillectomy. Eleven children, 73.3 per cent of the sample, had resolution of their CSA verified in the post-operative PSG.	No physiotherapist intervention

Legend: CSA (Central Sleep Apnoea); ASV (Adaptive Servo-Ventilation; BIPAP (Bilevel Positive Airway Pressure); CPAP (Continuous Positive Airway Pressure); SBD (Sleep Breathing Disorders); IPPV (Invasive Positive Pressure Ventilation); C-AHI (Central Apnoea-Hypopnoea Index); N (Sample size); PAP (Positive Airway Pressure); PSG (Polysomnography); SpO_2 (Peripheral Oxygen Saturation); UAW (Upper Airway); NIV (Non-invasive ventilation).

The interventions in which the physiotherapist collaborated, optimising the response to treatment, accounted for 42.30% of the therapeutic interventions addressed in the included studies. Among these interventions, oxygen therapy stands out at 11.53% (Ghirardo et al., 2021; Gurbani et al., 2017; Xiao et al., 2022) and non-invasive ventilation (NIV) by positive airway pressure (PAP) (Ghirardo et al., 2021; Gerdung et al., 2022; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Gurbani et al., 2017; Xiao et al., 2022), including intermittent positive pressure ventilation (IPPV) (Al-Saleh et al., 2017). The interventions with the participation of the physiotherapist were carried out in the different settings, inpatient, outpatient and home.

4. Discussion

The aim of this scoping review was to identify and map the therapeutic interventions most frequently referred to in the literature, including those that fall within the scope of the physiotherapist's work, for the treatment of CSA in children (0 to 18 years) and in different settings (hospital, outpatient and home)

All the studies selected in this review used retrospective methodology (Ghirardo et al., 2021; Gerdung et al., 2022; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Gurbani et al., 2017; Xiao et al., 2022; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al., 2012). One possible reason may be that this condition is difficult to diagnose in children, as it is often asymptomatic and in many cases associated with other comorbidities (Felix et al., 2016). According to El Dib (2016), retrospective studies are positive for less common themes and/or those that are not well documented in the literature; however, they are based on a methodology that is considered to be of low quality, which can present selection and data storage bias (Paolucci & Dib, 2007).

The children included in the studies consulted were diagnosed with CSA with mild, moderate and severe C-AHI, regardless of age group, although there was a higher frequency in males, which is consistent with reports in the literature. According to Chaves Junior et al. (2011), male gender is considered to be a predisposing and associated factor for central apnoea (Chaves Junior et al., 2011).

Most of the therapeutic interventions used were initiated in the context of hospitalisation (Ghirardo et al., 2021; Felix et al., 2016; Al-Saleh et al., 2017; Waich et al., 2022; Xiao et al., 2022; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al., 2012), which seems to be associated with the greater frequency of surgical therapeutic approaches. In three of the ten articles analysed, there was subsequent follow-up for outpatient and home care. According to Frange et al.(2022), oxygen therapy, pharmacological therapy and PAP therapy can be started in the outpatient setting, with appropriate follow-up at home (Frange et al., 2022).

The patient's insertion in each context is therefore dependent on the therapy chosen to treat CSA and the treatments associated with other comorbidities. There is also a change of context depending on the evolution of the patient's clinical condition. In more serious cases, they are cared for in hospital and followed up at home, after adapting to the therapy selected for treatment. According to Luiz et al. (2022) the home setting could be further explored as it reduces waiting lists in institutions and allows diagnostic methods to be used with portable equipment that is highly reliable.

With regard to the type of pathologies associated with the diagnosis of CSA, Chiari malformation and periodic breathing were the most frequently cited and associated with CSA when analysing the results (Ghirardo et al., 2021; Felix et al., 2016; Waich et al., 2022; Xiao et al., 2022; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al., 2012). This study corroborates the findings of previous research associating comorbidities with central sleep apnoea (CSA). Chiari malformation is characterised by caudal displacement of the cerebellum and herniation of the cerebellar tonsils (Vale et al., 2014). Periodic breathing (RP) includes a wide variety of breathing patterns, one of the best known of which is called Cheyne-Stokes breathing (CSB) (Ghirardo et al., 2021). Since CSA compromises structures such as the cerebellar vermis, brainstem and foramen magnum, it generates ventilatory instability in patients (Roberto, 2021).

It should be noted that CSA is rarely the primary diagnosis and is often seen in direct relation to a series of cardiovascular, metabolic and neurocognitive comorbidities (Baillieul et al., 2019). Less frequently, but deserving of the same level of attention, CSA can also be diagnosed after drug treatment or after mechanical ventilation, although there is still no definite explanation. One hypothesis is that these therapies may contribute to the variation in the apnoeic threshold (Frija-Masson et al., 2017).

As for the types of therapeutic intervention used to treat CSA in children, the most common in the studies selected for this review was upper airway surgery. Although the cause of CSA involves an interruption or dysfunction of ventilatory control in the central nervous system, four of the studies analysed Ghirardo et al., 2021; Boudewyns et al., 2016; Del-Río Camacho et al., 2019; Baldassari et al, 2012 state that otorhinolaryngological surgeries, such as tonsillectomy, adenoidectomy and adenotonsillectomy, when indicated for the treatment of children diagnosed with OSA and who also have significant associated CSA, are effective in reducing C-AHI. Among these surgical interventions, when pre- and post-operative indices are assessed, adenotonsillectomy seems to be more effective, with a significant reduction and, in some cases, normalisation of the children's C-AHI. It is worth noting that in this study, 50 per cent of the children had persistent CSA after adenotonsillectomy (Baldassari et al., 2012). Although the mechanism for improving the C-AHI after adenotonsillectomy is unclear, it is known that small changes in PaCO2 during sleep and partial or total pharyngeal collapse can stimulate mechanoreceptors in the upper airways and, through reflex mechanisms, can result in a temporary interruption of the respiratory impulse, leading to CSA events. Thus, correction of pharyngeal collapse can be considered as a possible therapeutic option in cases of CSA associated with OSA (Boudewyns et al., 2016).

Still on the use of surgical procedures, in the study by Ghirardo et al. (2021) otorhinolaryngological surgery was able to reduce the C-AHI in patients with predominantly obstructive sleep apnoea. The same study also confirmed that CSA is variably associated with obstructive events, as observed in previous studies, and that treating OSA in children can improve ventilatory control instability and lead to fewer central apnoeas during sleep (Baldassari et al., 2012).

However, a prevalence study by Waich et al. (2022) showed that during the period analysed (5 years), there was a reduction in the number of surgeries on the upper airways and an increase in the use of PAP therapies for the treatment of SBD in the paediatric population. In addition, watchful waiting, so called when there is no intervention of any kind but rather monitoring of symptoms and C-AHI, was preferred in asymptomatic children under the age of 1 (Waich et al., 2022).

However, in the studies by Ghirardo et al., (2021) and Xiao et al., (2022) babies with idiopathic central sleep apnoea (ICSA) were prescribed caffeine, and in some cases supplementary oxygen was also associated. Caffeine is a respiratory stimulant (with a short-term effect), used in late preterm infants, which reduces respiratory episodes and pauses, normalising the C-AHI in the first week of life in preterm infants, and is used as an adjuvant in infant ICSA. The efficacy of caffeine in the treatment of central apnoea in premature newborns has been demonstrated in several studies, as it reduces the C-AHI, $PaCO_2$, as well as the need for and duration of exposure to NIV or invasive mechanical ventilation. It also helps to re-establish the proper breathing pattern and increases alveolar ventilation. Although the use of caffeine has also been extrapolated to older children, there is minimal evidence to support this practice beyond a corrected gestational age of 44 weeks (Tropiano et al., 2016; Schmidt et al., 2007).

Although the therapeutic administration of neonatal caffeine does not appear to have any long-term effects on sleep duration or sleep apnoea during infancy, Marcus et al's (2014) randomised, controlled, double-blind study in ex-preterm infants found no long-term effect of caffeine use, showing that infants who were born prematurely, regardless of the level of caffeine administered, were at risk of obstructive sleep apnoea (Marcus et al., 2014). When analysing the therapies available for treating CSA in children, it is important to highlight the role of the physiotherapist. It was observed that the interventions in which the physiotherapist collaborated, optimising the response to treatment, accounted for a large part of the therapeutic interventions addressed in the included studies, with regard to procedures inherent to PAP therapy, NIV, IPPV and oxygen therapy.

The report of their approach consisted of adapting and monitoring patients undergoing PAP treatment, with the aim of optimising the patient's adaptation to the most suitable interface, adjusting the machine's comfort parameters, guiding the patient/caregivers on sleep hygiene care and observing the evolution of the user's symptoms, collaborating with strategies that aim to improve adherence and consequently treatment success with a reduction in C-AHI (Larissa Araújo Silva & Tairo Vieira Ferreira, 2022).

As described in the results, Positive Airway Pressure (PAP) was the second most frequent therapeutic intervention in the studies analysed. This therapy has various ventilation modes, which were chosen and adjusted according to the clinical condition presented by the children. When analysing the studies by Gerdung et al. (2022) and Felix et al. (2016) that used PAP as a treatment for CSA, it was found that the majority of individuals who obtained an improvement in the parameters of C-AHI, SpO_2 and ventilation had their CSA completely corrected. The studies consulted in this review show that supplementary oxygen therapy was used as first-line treatment in cases where the child diagnosed with CSA did not have hypoventilation (Gurbani et al., 2017). It is important to describe that, in cases of CSA in primary diagnosis in the paediatric age group, PAP therapy and oxygen therapy are presented as crucial therapies for improving the clinical picture (Gerdung et al., 2022).

The study by Xiao et al. (2022) shows the importance and effectiveness of PAP and oxygen therapy as a therapeutic approach in babies with idiopathic CSA, with a significant improvement in the C-AHI of all the children. However, the research carried out by Ghirardo et al. (2021) showed a negative prognosis, where the use of PAP in CPAP mode led to an increase in the AHI in a patient diagnosed with Down's Syndrome associated with CSA (Ghirardo et al., 2021).

In order to clarify the benefits of mechanical ventilation, the Al-Saleh et al. study (2017) identified the objectives of PAP, indicating the predictive indices of therapy failure. In the event of therapy failure, i.e. when the use of CPAP does not achieve these objectives, it is recommended to change or correct the ventilation mode until a gradual reduction or normalisation of the C-AHI is observed. In general, the aim of nocturnal CPAP or BIPAP in the treatment of SBD, according to the titration protocol adapted from the American Academy of Sleep Medicine (AASM) guidelines, is to achieve the following predictive indices: $SpO_2 > 93\%$, a reduced number of obstructive apnoeas, i.e. apnoea-hypopnoea index (AHI) < 1.5 events/hour and no significant increase in awakenings or oxygen desaturations; reduced central apnoeas and hypopnoeas (i.e. C-AHI < 1.0 event/hour); almost complete abolition of snoring, paradoxical breathing and flow limitation; reduction in respiratory work, including a reduction in total respiratory rate (RR) - generally to less than 25 cycles/min; $PaCO_2$ less than 50 mmHg for at least 25% of the night; reduction in nocturnal awakenings; improvement in sleep architecture and associated daytime symptoms (Berry et al. , 2017).

Still in relation to PAP treatment, in the findings of Gerdung et al. (2022), in which the majority of the sample had a diagnosis of moderate to severe SBD - mainly in children over the age of 12, CPAP was recommended more often, initiated in the presence of airway obstruction as well, and the titrated dosage eliminated predominantly obstructive events. BIPAP was administered to a small sample, to favour cases where airway obstruction or hypoventilation did not improve with CPAP and for patients with predominantly central apnoea events. In agreement, the findings of Gurbani et al. (2017) point out that BIPAP support was also administered in cases of CPAP therapeutic failure.

The study by Al-Saleh et al. (2017), carried out at the Hospital for Sick Children, states that children with an indication for using BIPAP are generally more clinically fragile than children on CPAP for SBD, a relevant clinical finding that indicates the need for careful assessment and monitoring, which will be part of the scope of practice of physiotherapists with specific knowledge of sleep-disordered breathing. Al-Saleh et al. (2017) suggest that to begin adapting new patients to CPAP, the initial pressure should be 4 cmH_2O, with increments of 1 to 2 cmH_2O as necessary to achieve the goals of therapy, with a maximum pressure of 15 cmH_2O. The ventilatory mode should be changed to BIPAP when CPAP fails, i.e. when the goals of therapy are not achieved. When patients are started in spontaneous/timed BIPAP mode, Expiratory positive airway pressure (EPAP) and Inspiratory positive airway pressure (IPAP) should be started with a baseline of 4/8 cmH_2O, both increased by 1 to 2 cmH_2O as necessary, always maintaining a minimum support pressure of 4 cmH_2O. The minimum and maximum inspiratory time, rise time, trigger and cycle sensitivity should be adjusted based on bedside observation (in situ) to improve patient-ventilator synchrony.

In the analysis of the use of other ventilation modes by PAP, a single study used the ASV ventilation mode to treat a child with severe CSA (C-AHI 50 events/hour) associated with the diagnosis of a ganglioglioma-type central nervous system tumour in the cervical spinal cord region, which was successfully treated with this type of ventilation mode after CSA persisted postoperatively following cervicomedullary decompression surgery (Felix et al., 2016). This is in line with the study by Vale et al. (2014) in the adult population, which reports a good response to the patient's adaptation to ASV in cases of persistent CSA after cervicomedullary decompression. New surgery is generally not performed given the associated risk of respiratory depression.

In the study by Al-Saleh et al. (2017), treatment with IPPV was chosen for patients with high C-AHI associated with a specific genetic or medical condition, until the triggering factor for CSA was identified and treated. The parameters were adjusted at the bedside by a respiratory therapist, prioritising good synchrony between the ventilator and the patient. In this study, 25 users who were using IPPV underwent titration and showed a good response to treatment.

Another very frequent therapeutic intervention in the studies consulted was drug treatment with the use of acetazolamide. Acetazolamide was used in the studies by Ghirardo et al. (2021) and Felix et al. (2016) for patients with Prader Willi Syndrome associated with CSA and a 50 per cent reduction in C-AHI was observed. In the study by Gurbani et al. (2017), 7 of the 14 patients were treated with acetazolamide, but the comorbidities were not described. In all the studies, the patients treated with acetazolamide showed an improvement in their general clinical condition. Acetazolamide is a carbonic anhydrase inhibitor, triggering metabolic acidosis which probably increases the ventilatory response to variations in $PaCO_2$ levels and has also been shown to reduce CSA (Xiao et al., 2022). However, due to the scarcity of literature, the long-term prognosis in these patients is unknown (Philippi et al., 2001).

In the last decade, there has been an increase in the number of studies on SBD, which address the study, reporting and understanding of changes in sleep and wake rhythm, encompassing individuals from childhood to adulthood, and taking into account the associated cardiovascular, endocrine and metabolic complications, however, these are still scarce and their conclusions limited (Rafihi-Ferreira et al., 2020).

Even so, the use of therapeutic strategies within the scope of the physiotherapist's role is notorious, efficiently assisting patients undergoing treatment with ventilotherapy, associated or not with oxygen therapy, with the aim of promoting health and quality of life. As part of the hospital team, physiotherapists must be able to carry out a careful assessment and monitoring, recognising signs of hypoxaemia, hyperoxia, changes in breathing pattern and risk situations, whether in hospital, outpatient or at home, ensuring adequate monitoring of vital functions (Ramos et al., 2022).

This study has some limitations. The studies eligible for this scoping review were observational or retrospective cohort studies with a low level of evidence, which limits the study's conclusions (Oxford Centre for Evidence-Based Medicine, 2009). In this type of study, there are certain types of bias, with important implications for the conclusions, such as selection bias, sampling bias, since the sample is usually by convenience and not random or representative of the population of interest, or non-participation bias, since a significant part of the sample may not have been followed up due to complications or even survival. There may therefore have been an underestimation or overestimation of the association between exposure and the outcome sought in the studies. Furthermore, the studies included have heterogeneous methodologies, with samples in different age groups, making it difficult to directly compare the results.

However, despite these important limitations, this scoping review can be a valuable starting point for future research, centred on quantitative studies that address the topics discussed, as it demonstrates a large gap in the literature on the therapies used in CSA in paediatrics, pointing to the need to carry out studies with robust methodologies.

Future studies with higher methodological quality are therefore recommended, such as Randomised Controlled Trials, comparing the different therapies in children diagnosed with CSA and including duly randomised control groups.

5. Conclusion

With this scoping review, it was possible to identify that the most frequently used therapeutic interventions for the treatment of Central Sleep Apnoea in paediatrics were: ENT surgery, followed by Positive Airway Pressure (PAP) therapy, which are commonly initiated in inpatient settings, followed by outpatient settings, respectively. Oxygen therapy and PAP (NIV, IPPV) were included in the physiotherapist's scope of action in different contexts.

However, this study also shows that there is a large gap in the literature on the therapeutic interventions used in CSA in paediatrics, pointing to the need to carry out studies with robust methodologies that attest to this type of intervention.

References

Al-Saleh, S., Sayal, P., Stephens, D., Florence, J., Sayal, A., Baker, A., Syed, F., Narang, I., & Amin, R. (2017). Factors Associated with Changes in Invasive and Noninvasive Positive Airway Pressure Therapy Settings during Pediatric Polysomnograms. Journal of Clinical Sleep Medicine, 13(02), 183–188. https://doi.org/10.5664/jcsm.6442

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a Methodological Framework. International Journal of Social Research Methodology, 8(1), 19–32. https://doi.org/10.1080/1364557032000119616

Baillieul, S., Revol, B., Jullian-Desayes, I., Joyeux-Faure, M., Tamisier, R., & Pépin, J.-L. (2019). Diagnosis and management of central sleep apnea syndrome. Expert Review of Respiratory Medicine, 13(6), 545–557. https://doi.org/10.1080/17476348.2019.1604226

Balbani, A. P. S., Weber, S. A. T., Montovani, J. C., & Carvalho, L. R. de. (2005). Pediatras e os distúrbios respiratórios do sono na criança. Revista Da Associação Médica Brasileira, 51(2), 80–86. https://doi.org/10.1590/s0104-42302005000200014

Baldassari, C. M., Kepchar, J., Bryant, L., Beydoun, H., & Choi, S. (2012, March). Changes in Central Apnea Index following Pediatric Adenotonsillectomy [Review of Changes in Central Apnea Index following Pediatric Adenotonsillectomy]. Otorryngology-Head and Neck Surgery, 146(3), 345–519. https://aao-hnsfjournals.onlinelibrary.wiley.com/doi/10.1177/0194599811428118

Berry, R. B., Brooks, R., Gamaldo, C., Harding, S. M., Lloyd, R. M., Quan, S. F., Troester, M. T., & Vaughn, B. V. (2017). AASM Scoring Manual Updates for 2017 (Version 2.4). Journal of Clinical Sleep Medicine, 13(05), 665–666. https://doi.org/10.5664/jcsm.6576

Boudewyns, A., Van de Heyning, P., & Verhulst, S. (2016). Central apneas in children with obstructive sleep apnea syndrome: prevalence and effect of upper airway surgery. Sleep Medicine, 25, 93–97. https://doi.org/10.1016/j.sleep.2016.05.018

Carrilho, M. J. (2015). Crianças e Adolescentes em Portugal. Revista de Estudos Demográficos, 53–101. Instituto Nacional de Estatistica. https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpub_boui=224830908&PUBLICACOESmodo=2&xlang=pt

Chaves Junior, C. M., Dal-Fabbro, C., Bruin, V. M. S. de, Tufik, S., & Bittencourt, L. R. A. (2011). Consenso brasileiro de ronco e apneia do sono: aspectos de interesse aos ortodontistas. Dental

Press Journal of Orthodontics, 16(1), e1–e10. https://doi.org/10.1590/s2176-94512011000100007

Del-Río Camacho, G., Medina Castillo, L., Rodríguez-Catalán, J., Soto Insuga, V., & Gómez García, T. (2019). Central sleep apnea in children with obstructive sleep apnea syndrome and improvement following adenotonsillectomy. Pediatric Pulmonology, 54(11), 1670–1675. https://doi.org/10.1002/ppul.24469

ESPECIALIDADES DA FISIOTE RAPIA. (n.d.). https://www.crefito5.org.br/wp-content/uploads/2017/08/Manual-Especialidades-Online.pdf.

Felix, O., Amaddeo, A., Olmo Arroyo, J., Zerah, M., Puget, S., Cormier-Daire, V., Baujat, G., Pinto, G., Fernandez-Bolanos, M., & Fauroux, B. (2016b). Central sleep apnea in children: experience at a single center. Sleep Medicine, 25, 24–28. https://doi.org/10.1016/j.sleep.2016.07.016

Frange, C., Franco, A. M., Brasil, E., Hirata, R. P., Lino, J. A., Mortari, D. M., Ykeda, D. S., Leocádio-Miguel, M. A., D'Aurea, C. V. R., Silva, L. O. e, Telles, S. C. L., Furlan, S. F., Peruchi, B. B., Leite, C. F., Yagihara, F. T., Campos, L. D., Ulhôa, M. A., Cruz, M. G. da R., Beidacki, R., & Santos, R. B. (2022). Practice recommendations for the role of physiotherapy in the management of sleep disorders: the 2022 Brazilian Sleep Association Guidelines. Sleep Science, 15(4). https://doi.org/10.5935/1984-0063.20220083

Frija-Masson, J., Wanono, R., Robinot, A., & d'Ortho, M.-P. (2017). Syndrome d'apnées centrales du sommeil. La Presse Médicale, 46(4), 413–422. https://doi.org/10.1016/j.lpm.2016.11.003

Gerdung, C. A., Castro-Codesal, M. L., Nettel-Aguirre, A., Kam, K., Hanly, P. J., MacLean, J. E., & Bendiak, G. N. (2022). Feasibility of split night polysomnography in children to diagnose and treat sleep related breathing disorders. Sleep Medicine. https://doi.org/10.1016/j.sleep.2022.05.011

Ghirardo, S., Amaddeo, A., Griffon, L., Khirani, S., & Fauroux, B. (2021). Central apnea and periodic breathing in children with underlying conditions. Journal of Sleep Research. https://doi.org/10.1111/jsr.13388

Gurbani, N., Verhulst, S. L., Tan, C., & Simakajornboon, N. (2017). Sleep Complaints and Sleep Architecture in Children With Idiopathic Central Sleep Apnea. Journal of Clinical Sleep Medicine, 13(06), 777–783. https://doi.org/10.5664/jcsm.6614

Larissa Araújo Silva, & Tairo Vieira Ferreira. (2022). ATUAÇÃO DO FISIOTERAPEUTA NO TRATAMENTO DE PACIENTES COM DISTÚRBIOS RESPIRATÓRIOS DO SONO. Revista Multidisciplinar Do Nordeste Mineiro, 10(1). https://revista.unipacto.com.br/index.php/multidisciplinar/article/view/1181

Luiz, R., Duarte, M., Maria, S., Pereira Togeiro, G., De Oliveira Palombini, L., Paula, F., Rizzatti, G., Chaves Fagondes, S., Magalhães-Da-Silveira, J., Montenegro Cabral, M., Rodrigues Genta, P., Lorenzi-Filho, G., Cristina, D., Clímaco, S., Ferreira Drager, L., Martins Codeço, V., Alberto, C., Viegas, A., & Rabahi, M. (2022). Consenso em Distúrbios Respiratórios do Sono da Sociedade Brasileira de Pneumologia e Tisiologia, 48(4):1-26. https://doi.org/10.36416/1806-3756/e20220106

Madan Jha, V. (2023). The prevalence of sleep loss and sleep disorders in young and old adults. Aging Brain, 3, 100057. https://doi.org/10.1016/j.nbas.2022.100057

Marcus, C. L., Meltzer, L. J., Roberts, R. S., Traylor, J., Dix, J., D'ilario, J., Asztalos, E., Opie, G., Doyle, L. W., Biggs, S. N., Nixon, G. M., Narang, I., Bhattacharjee, R., Davey, M., Horne, R. S. C., Cheshire, M., Gibbons, J., Costantini, L., Bradford, R., & Schmidt, B. (2014). Long-Term Effects of Caffeine Therapy for Apnea of Prematurity on Sleep at School Age. American Journal of Respiratory and Critical Care Medicine, 190(7), 791–799. https://doi.org/10.1164/rccm.201406-1092oc

McLaren, A. T., Bin-Hasan, S., & Narang, I. (2019). Diagnosis, management and pathophysiology of central sleep apnea in children. Paediatric Respiratory Reviews, 30, 49–57. https://doi.org/10.1016/j.prrv.2018.07.005

Oxford Centre for Evidence-Based Medicine. (2009). Oxford Centre for Evidence-Based Medicine: Levels of Evidence (March 2009) — Centre for Evidence-Based Medicine, University of Oxford. Www.cebm.ox.ac.uk. https://www.cebm.ox.ac.uk/resources/levels-of-evidence/oxford-centre-for-evidence-based-medicine-levels-of-evidence-march-2009

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., & McGuinness, L. A. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. British Medical Journal, 372(71). https://doi.org/10.1136/bmj.n71

Paolucci, R., & Dib, E. (2007). Como praticar a medicina baseada em evidências How to practice evidence-based medicine. J Vasc Bras, 6(1), 1–4. https://www.scielo.br/j/jvb/a/Dhy8TqBdZJgGcL7SwCmBK6r/?format=pdf&lang=pt

Peters, M. D. J., Godfrey, C., McInerney, P., Cássia Baldini Soares, Khalil, H., & Parker, D. (2015). The Joanna Briggs Institute reviewers' manual 2015: methodology for JBI scoping reviews.

Philippi, H., Bieber, I., & Reitter, B. (2001). Acetazolamide Treatment for Infantile Central Sleep Apnea. Journal of Child Neurology, 16(8), 600–603. https://doi.org/10.1177/088307380101600813

Pires, P. J. S., Mattiello, R., Lumertz, M. S., Morsch, T. P., Fagondes, S. C., Nunes, M. L., Gozal, D., & Stein, R. T. (2019). Validation of the Brazilian version of the Pediatric Obstructive Sleep Apnea Screening Tool questionnaire. Jornal de Pediatria, 95(2), 231–237. https://doi.org/10.1016/j.jped.2017.12.014

Rafihi-Ferreira, R. E., Muller, M. R., & Pires, M. L. N. (2020). Apneia do Sono na Infância e a Contribuição da Psicologia do Sono na Adesão ao Tratamento. Revista Da SBPH, 23(1), 147–157. http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1516-08582020000100013

Ramos, T. R., Fernandes, E. D. S., Da Costa, R. F., Dos Santos Sánchez, A. P., Silva de Morais, M. C., & Correia Viana, M. C. (2022). Vivência de fisioterapeutas com pacientes hospitalizados sob oxigenoterapia. Journal of Health & Biological Sciences, 10(1), 1. https://doi.org/10.12662/2317-3076jhbs.v10i1.4458.p1-6.2022

Roberto, C. (2021). Neurologia de A-Z. Thieme Revinter

Ross, K. R., & Rosen, C. L. (2014). Sleep and Respiratory Physiology in Children. Clinics in Chest Medicine, 35(3), 457–467. https://doi.org/10.1016/j.ccm.2014.06.003

Santos, C. M. da C., Pimenta, C. A. de M., & Nobre, M. R. C. (2007). The PICO strategy for the research question construction and evidence search. Revista Latino-Americana de Enfermagem, 15(3), 508–511. https://doi.org/10.1590/s0104-11692007000300023

Sateia, M. J. (2014). International Classification of Sleep Disorders-Third Edition. Chest, 146(5), 1387–1394. https://doi.org/10.1378/chest.14-0970

Schmidt, B., Roberts, R. S., Davis, P., Doyle, L. W., Barrington, K. J., Ohlsson, A., Solimano, A., & Tin, W. (2007). Long-Term Effects of Caffeine Therapy for Apnea of Prematurity. New England Journal of Medicine, 357(19), 1893–1902. https://doi.org/10.1056/nejmoa073679

Tropiano, L. M. da C. C., Azevedo, A., Fernandes, M., Salerno, G. R. F., Vianna, D. L., & Santos, J. C. M. dos. (2016). Relação entre incidência de apneia em recém nascidos e consumo materno de cafeína na gestação. Cadernos de Pós-Graduação Em Distúrbios Do Desenvolvimento, 16(1), 8–16. http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1519-03072016000100002

Vale, J. M. do, Silva, E., Pereira, I. G., Marques, C., Sanchez-Serrano, A., & Torres, A. S. (2014). Chiari malformation and central sleep apnea syndrome: efficacy of treatment with adaptive servo-ventilation. Jornal Brasileiro de Pneumologia, 40(5), 574–578. https://doi.org/10.1590/s1806-37132014000500014

Waich, A., J. Ruiz Severiche, Margarita Manrique Andrade, Castañeda, A., César, J., Otero, L., Maria, S., O.P. Panqueva, & Patricia Hidalgo Martínez. (2022). Prevalence of sleep apnea in children and adolescents in Colombia according to the national health registry 2017–2021. PLOS ONE, 17(8), e0273324–e0273324. https://doi.org/10.1371/journal.pone.0273324

Wheeler, J. A., Tutrow, K., Ebenroth, E. S., Gaston, B., & Bandyopadhyay, A. (2021). Heart failure is not a determinant of central sleep apnea in the pediatric population. Pediatric Pulmonology, 56(5), 1092–1102. https://doi.org/10.1002/ppul.25242

Xiao, L., Sunkonkit, K., Chiang, J., & Narang, I. (2022). Unexplained Significant Central Sleep Apnea in Infants: Clinical Presentation and Outcomes. Sleep and Breathing. https://doi.org/10.1007/s11325-022-02612-3

Appendices

Appendix I

Cross-referencing of descriptors used in the research.

OPTION	USED CROSS-REFERENCING
1	(Sleep Apnea, Central) AND (Child)
2	(((Sleep Apnea, Central) AND (Child)AND (Therapeutic))
3	(((Sleep Apnea, Central) AND (Positive Airway Pressure)) AND (Non invasive ventilation)) AND (Child)
4	(((Sleep Apnea, Central) AND (Child)AND (treatment))
5	(((Sleep Apnea, Central) AND (Pediatrics)AND (Therapeutic))
6	(((Sleep Apnea, Central) AND (Non invasive ventilation)) AND (Child)
7	(((Sleep Apnea, Central) AND (Child)AND (Therapeutic Aprroaches))
8	(((Sleep Apnea, Central) AND (Surgery) AND (Child))
9	((ALL=(apneia central do sono)) AND ALL=(cirurgia)) AND ALL=(criança)
10	((ALL=(apneia central do sono)) AND ALL=(cirurgia)) AND ALL=(pediatria)
11	(((Sleep Apnea, Central) AND (drug therapy) AND (Child))
12	(((Sleep Apnea, Central) AND (drug therapy) AND (Pediatrics))
13	((ALL=(apneia central do sono)) AND ALL=(tratamento farmacologico)) AND ALL=(criança)
14	((ALL=(apneia central do sono)) AND ALL=(tratamento farmacologico)) AND ALL=(pediatria)
15	((ALL=(Sleep Apnea, Central)) AND ALL=(Respiratory fisioterapy)) AND ALL=(child)
16	((ALL=(Sleep Apnea, Central)) AND ALL=(Respiratory fisioterapy)) AND ALL=(Pediatrics)
17	((ALL=(apneia central do sono)) AND ALL=(fisioterapia respiratoria)) AND ALL=(criança)
18	((ALL=(apneia central do sono)) AND ALL=(fisioterapia respiratoria)) AND ALL=(pediatria)
19	((ALL=(Sleep Apnea, Central)) AND ALL=(Oxygen Inhalation Therapy)) AND ALL=(child)

20	((ALL=(Sleep Apnea, Central)) AND ALL=(Oxygen Inhalation Therapy)) AND ALL=(Pediatrics)
21	((ALL=(apneia central do sono)) AND ALL=(oxigenoterapia)) AND ALL=(criança)
22	((ALL=(apneia central do sono)) AND ALL=(oxigenoterapia)) AND ALL=(pedriatria)
23	((ALL=(Sleep Apnea, Central)) AND ALL=(Invasive ventilation)) AND ALL=(Child)
24	((ALL=(Sleep Apnea, Centra)) AND ALL=(Invasive ventilation)) AND ALL=(Pediatrics)
25	((ALL=(apneia central do sono)) AND ALL=(ventilação invasiva)) AND ALL=(criança)
26	((ALL=(apneia central do sono)) AND ALL=(ventilação invasiva)) AND ALL=(pedriatria)
27	((ALL=(apneia central do sono)) AND ALL=(fisioterapia respiratoria)) AND ALL=(criança)