Article

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Management of chronic fatigue syndrome/myalgic encephalomyelitis in a pediatric population: A scoping review

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Abstract

Chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) negatively impacts the quality of life for children with the condition. Although up to 2% of children have CFS/ME, the bulk of research investigates adults with CFS/ME. Using the PRISMA extension for a scoping review and the work of Arksey and O'Malley (2005), a scoping review was conducted of all relevant peer-reviewed research investigating nutrition, exercise, and psychosocial factors within a pediatric population diagnosed with CFS/ME. Key themes found were nutrition and dietary components, exercise therapy, psychosocial factors, and multifaceted treatment. Nutrition was explored on its own as a tool to decrease symptoms; however, there were very few studies found to examine nutritional deficiency or treatment with those under the age of 18. Graded exercise and resistance training improved fatigue severity and symptoms of depression in adolescents with CFS/ME. Research exploring psychosocial factors of CFS/ME presented attributes that could lead to being diagnosed as well as barriers to treatment. The multifaceted treatment undertaken typically consists of graded activities/exercise, cognitive behavioral therapy, nutritional advice, and family sessions. This has shown to increase school attendance and decrease the severity of the fatigue for adolescents. Minimal literature exploring CFS/ME within a prepubescent population presents the need for further research.

Keywords

Adolescent, children, chronic fatigue syndrome, myalgic encephalomyelitis, pediatric

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Introduction

Chronic fatigue syndrome (CFS)/myalgic encephalomyelitis (ME) is a serious and relatively common condition characterized by overwhelming fatigue and a decrease in physical and cognitive function (Mackenzie and Wray, 2013; Rowe et al., 2017). Pediatric CFS/ME has a prevalence of 0.4–2.4% (Chalder et al., 2003; Crawley et al., 2011; Crawley et al., 2012; Rimes et al., 2007) in population studies and .06–.1% (Haines et al., 2005; Nijhof et al., 2011) within a hospital setting. ME/CFS affects all ages, ethnicities, and socio-economic status (Rowe et al., 2017). For adults, it has been found that there is a higher prevalence in women (Nacul et al., 2011). Recognition of this disabling condition is increasing and incidence peaks at 10–19 years and 30–39 years (Bakken et al., 2014; Parslow et al., 2017a).

CFS/ME negatively impacts quality of life (QOL) for children (Collin et al., 2016; Mackenzie and Wray, 2013). Physical symptoms such as a sore throat, joint and muscle pain, nausea, heightened inactivity, and sleep dysfunction have been identified in children with CFS/ME (Collin et al., 2015). Other cognitive and psychosocial symptoms include cognitive dysfunction, social isolation, depression, and anxiety (Collin et al., 2015). It is a complex condition; the etiology is unknown, and currently, there is no known cure (Collin et al., 2015; Richards et al., 2006; Rowe et al., 2017).

Studies have shown that dietary, exercise, and psychosocial factors can reduce symptoms and improve QOL (Jenkins and Rayman, 2005; Lopez et al., 2011; Maes et al., 2006; Maric et al., 2014). Thus appropriate nutrition, exercise, and psychosocial management strategies may be beneficial in alleviating symptoms and improving QOL in children with CFS/ME. The objective of this article is to conduct a scoping review exploring current peer-reviewed research investigating these strategies to decrease symptoms of CFS/ME within a pediatric population (aged under 18 years). Therefore, the research question was: What has been shown in the literature investigating management of CFS/ME in a pediatric population within the key areas of nutrition, exercise, psychology and social factors?

Methods

Following PRISMA extension for scoping review guidelines (Tricco et al., 2018) and the work of Arksey and O'Malley (2005), a comprehensive electronic literature search of relevant peer-reviewed journal articles was conducted by the main researcher (SC). Subsequent hand searching of relevant articles and reports was conducted to identify additional literature. Inclusion criteria consisted of peer-reviewed research investigating clinically diagnosed individuals with CFS/ME who are under the age of 18; research exploring nutritional components, exercise and/or physical activity, and lifestyle and wellbeing for children with CFS/ME; and psychosocial factors that may influence the treatment and diagnosis of CFS/ME. Excluded literature investigated individuals with no medical diagnosis of CFS/ME; adults (over 18 years old) with CFS/ME; not peer-reviewed research or commentary/opinion pieces; and research prior to 1994 as this was the date of the published clinical definition of CFS/ME.

Databases used to search were CINAHL, Medline complete, Psychinfo, SportDiscus, PubMed and NICE evidence series. Multiple search terms were used to obtain findings. Such terms included child, adolescent, chronic fatigue syndrome, myalgic encephalomyelitis, CFS, ME, nutrition, trace elements (e.g., zinc, selenium, copper, aluminium, iron, magnesium), supplement, exercise, physical activity, lifestyle, wellbeing, family, treatment, therapy, environment, and psychology.

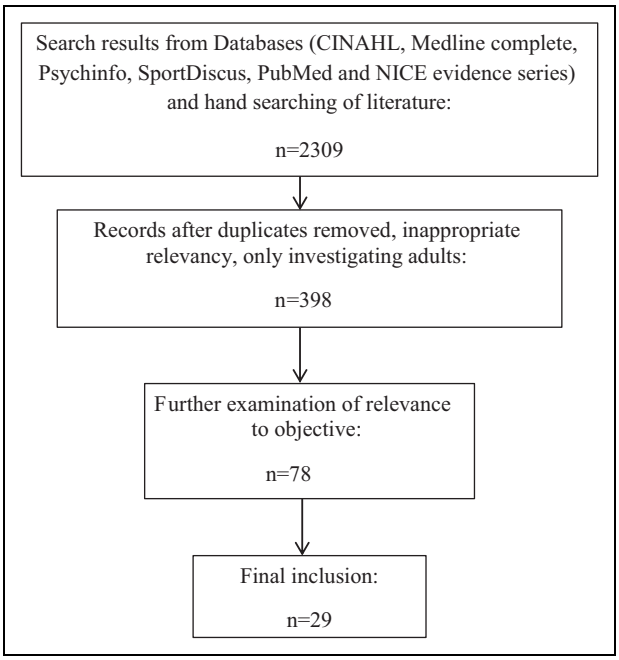

Figure 1. Search strategy and selection process.

Boolean operators and truncation of search terms were used to obtain a larger amount of the research results that were relevant. Following a comprehensive literature search by SC, the decisions of inclusion of literature were discussed with the second author (JM). As a result, 29 peer-reviewed research articles were used within this review (see Figure 1).

Upon finalizing the search, SC developed a data charting form to collate the literature and extract the descriptive characteristics of the studies (e.g., authors, date, title, method, key findings). The finalized data chart was discussed with the co-author and approved (see Table 1). The data extracted for analysis consisted of the participants' descriptions (e.g., age, male, female), main focus (e.g., nutrition, exercise, psychology therapy, etc.) and results. Once finalized, exploration of the relationships between studies (thematic analysis) was conducted and the strength of the summarized report was assessed (refining and organizing themes to provide an overall thematic summary). This was reviewed by JM and discussed with SC for the final article.

Results

The initial literature search found 2309 records. Upon removing duplicates, studies only investigating adults, and those that were not relevant to this review, 398 papers remained. Further exclusions in relation to the focus and age of participants initially reduced the total to 78 articles, followed by further scrutiny of age of participants and focus of objective which resulted in 29 papers being included (see Figure 1).

Table 1. Summary of research included.

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Biofeedback and cognitive behavioral therapy for Egyptian adolescents suffering from chronic fatigue syndrome; Al-Haggar et al. (2006)	Evaluate the efficacy of CBT with biofeedback in adolescents with CFS	RCT	92 adolescents (mean age 12.52 $\pm$ 3.32 years)	Egypt	CBT aided by biofeedback intervention group versus control group. Assessed post-intervention: fatigue, school attendance, CFS symptoms	Fatigue severity was significantly lower and school attendance significantly higher in intervention group compared to the control group. Self-reported decreased in intervention group
Chronic fatigue syndrome: an evaluation of a community based management programme for adolescents and their families; Ashby et al. (2006)	Assess community-based programme	N/A	10 children and adolescents (8–16 years old) and their parents	United Kingdom	Semi-structured interviews	Positive feedback of the approach conducted to include the family within the programme
Chronic fatigue syndrome (CFS) or myalgic encephalomyelitis is different in children compared to in adults: a study of UK and Dutch clinical cohorts; Collin et al. (2015)	Examine differences between young children, adolescents and adults with CFS	N/A	United Kingdom (2004–2014) and the Netherlands (2008–2010) database; 1568 United Kingdom adolescents (12–18 years) and 210 (under 12); 135 Dutch adolescents	United Kingdom and the Netherlands	Investigation of clinical cohorts from the United Kingdom and RCT from the Netherlands; multiple outcome measures	Younger aged children had less of a gender imbalance. Differences in elevated symptoms and range of symptoms depending on the age

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Chronic fatigue syndrome at age 16 years; Collin et al. (2015)	Estimate the prevalence of CFS at 16 years of age	N/A	14,541 pregnancies and 13,978 children alive at 12 months of age (excluding triplets and quads)	United Kingdom	ALSPAC data to estimate the prevalence of CFS at age 16. Used parent report of unexplained disabling fatigue lasting ≥six months; ALSPAC Family Adversity Index; school absence data	Family adversity created higher risk of diagnosis of CFS. Female gender posed higher risk at 16 years of age as well as other mental health concerns
Maternal and childhood psychological factors predict chronic disabling fatigue at age 13 years; Collin et al. (2015)	Investigate if premorbid maternal and childhood psychological problems are risk factors for CFS at age 13	N/A	110 children of 5657 by age 13; data from the Avon Longitudinal Study of Parents and Children	United Kingdom	Edinburgh Postnatal Depression Scale and the Crown-Crisp Experiential Index at multiple time points	Mental health of both child and mother is a risk factor for CFS
Comparing specialist medical care with specialist medical care plus the Lightning Process® for chronic fatigue syndrome or myalgic encephalomyelitis (CFS/ME): study protocol for a randomised control trial (SMILE Trial); Crawley et al. (2013)	Examine the effectiveness of Lightning Process to Standard medical care and details on implementation	RCT	80 participants (12–18 years old)	United Kingdom	RCT: Standard medical care or Standard medical care plus Lightning Process; primary outcomes are physical function (SF-36 physical function short form) and fatigue (Chalder Fatigue Scale)	Ongoing

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Clinical and cost-effectiveness of the Lightning Process in addition to specialist medical care for pediatric chronic fatigue syndrome: randomized control trial; Crawley et al. (2017)	Compare effectiveness and cost-effectiveness of Lightning Process plus specialist medical care to Standard medical care alone in children with CFS/ME	RCT	100 participants (12–18 years old)	United Kingdom	Measured at multiple times (3, 6 and 12 months). Primary outcome measure: SF-36-PFS (six months). Secondary measures: pain, anxiety, depression, school attendance and cost-effectiveness from health service viewpoint (3, 6 and 12 months)	Lightning Process plus Standard medical care improved physical function, fatigue, decreased anxiety and depression, and improved school attendance. This was after 6 and 12 months. Cost-effective for mild to moderately affected adolescents in relation to health-related quality of life. Not all children wanted to take part and the reasons were not known
A multidimensional treatment plan for chronic fatigue syndrome; Gibson and Gibson (1999)	Test validity of multi-therapeutic treatment for people with CFS	Treatment-dietary intervention	64 participants completed (10–59 years old)	United Kingdom	Six-month treatment intervention; intervention-wheat-free diet with nutritional supplements; homeopathic treatment of allergies; homeopathic constitutional prescribing; psychotherapy	70% benefited wheat-free diet and supplements most helpful

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Graduated exercise training and progressive training in adolescents with chronic fatigue syndrome: a randomized controlled pilot study; Gordon and Knapman (2010)	Effects of aerobic graded exercise and progressive resistance training on exercise intolerance, fatigue and quality of life	RCT	22 participants (aged 13–18)	Australia	Measures: exercise tolerance, metabolic equivalents, quality of life, muscular strength and endurance. Evaluation of depressive symptoms and fatigue severity	No significant difference between groups. Improvement in physical capacity and quality of life. Fatigue severity and depressive symptoms only improved in aerobic training group
Promising outcomes of an adolescent chronic fatigue syndrome inpatient programme; Gordon and Lubitz (2009)	Impact of graded exercise programme on physical outcomes, fatigue and mental state	Exercise programme assessment	16 participants (mean age: 16.2 $\pm$ 1.28 years)	Australia	Outcome measures: quality of life, fatigue and depression; exercise assessment pre and post-treatment	GET significantly improves aerobic capacity. Improvement in depression scores. Fatigue severity improved
A qualitative investigation of eating difficulties in adolescents with chronic fatigue syndromes/myalgic encephaliomyelitis; Harris et al. (2017)	Exploring impact of eating difficulties in children with CFS	N/A	11 participants (aged 12–17 years)	United Kingdom	Semi-structured interviews; thematic analysis	Difficulties caused by being too fatigued, low mood to eat and changes to their taste and smell. Variety of adaptations to ease difficulties
Early Adverse Experience and Risk for Chronic Fatigue Syndrome; Heim et al. (2006)	Investigate the relationship between early adverse experience and risk for CFS	N/A	43 individuals with CFS and 60 healthy Control participants (73 total) (18–69 years old)	United States	Self-reported childhood trauma and psychopathology	Higher response of childhood trauma from those with CFS/ME. Childhood trauma increased severity of symptoms in those with CFS/ME

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Interventions in pediatric chronic fatigue syndrome/ myalgic encephalomyelitis: a systematic review; Knight et al. (2013)	Systematic review of literature on interventions for paediatric CFS/ME	N/A	Children and/or adolescents (≤18 years of age)	N/A	PRISMA guidelines for systematic review; databases searched: CINAHL, PsycINFO and Medline; 24 papers on 21 studies were included	Strongest evidence for CBT. Only one study examining exercise therapy in isolation. No evidence of detrimental impact of exercise as therapy. Lack of research in efficacy and safety of pharmaceutical or immunological treatment
A review of the predisposing, precipitating and perpetuating factors in chronic fatigue syndrome in children and adolescents; Lievesley et al. (2014)	Review of CFS in children and adolescents	N/A	N/A	N/A	Narrative synthesis; multiple databases searched; published articles from 1980 to 2013	Psychiatric comorbidity higher in young people with CFS compared to healthy controls. Infection prior to diagnosis. Psychological and social risk factors (e.g., family history of CFS) had mixed results
Chronic fatigue syndrome: successful outcome of an intensive inpatient programme; Lim and Lubitz (2002)	Study the outcome of an intensive multidisciplinary inpatient programme	Multidisciplinary inpatient programme	59 adolescents completed the programme (ages 10–19); 42 returned the questionnaire	Australia	Measured three months to five years after completion of the programme	Improvement in school attendance and physical activity. Symptoms improved overall

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Telephone-based guided self-help for adolescents with chronic fatigue syndrome: a non-randomised cohort study; Lloyd et al. (2012)	Examine the efficacy of a telephone-based guided self-help intervention for adolescents with CFS	Preliminary evidence	63 participants (11–18 years old)	United Kingdom	Outcome measures completed at baseline, pretreatment, end of treatment and at three and six months post-treatment. Primary outcomes: Fatigue (Chalder Fatigue Scale) and School attendance. Secondary outcomes: Impairment (Social Adjustment Scale), depression (Birleson Feelings Scale), adjustment (Strengths and Difficulties Questionnaire Total Difficulties Scale), anxiety (Spence Children's Anxiety Scale), perfectionism (Child and Adolescent Perfectionism Questionnaire) and maternal mental wellbeing (General Health Questionnaire)	Decrease in fatigue and significant increase in school attendance

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Chronic fatigue syndrome in children and young people; Mackenzie and Wray (2013)	Reviews the best approach to assessment, diagnosis and management of CFS/ME in children and young people	N/A	N/A	N/A	Literature review	Early diagnosis and appropriate multidisciplinary intervention aid recovery. Further research needed to improve understanding and management of condition in young people
Internet-based therapy for adolescents with CFS: long-term follow-up; Nijhof et al. (2013)	Assessing long-term outcome of CFS for adolescents after FITNET	FITNET trial	112 participants (aged 12–18 years)	Netherlands	Long-term follow-up (mean 2.7 years) of FITNET. Primary outcomes: fatigue severity (Checklist Individual Strength-20), physical functioning (87-iten Child Health Questionnaire) and school/work attendance	Short-term effectiveness of FITNET is maintained at long-term follow-up
Children's experiences of chronic fatigue syndrome/ myalgic encephalomyelitis (CFS/ME): a systematic review and meta-ethnography of qualitative studies; Parslow et al. (2017a)	Conduct a review of the qualitative studies presenting children's experiences of CFS/ME	N/A	N/A	N/A	Systematic review and meta-ethnography	Biographical disruption; barriers and facilitators to coping; emotional aspects of recovery

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Important factors to consider when treating children with chronic fatigue syndrome/ myalgic encephalomyelitis (CFS/ME): perspectives of health professionals from specialist services; Parslow et al. (2017b)	To understand the perspectives of pediatric CFS/ME health professionals and identify outcomes that are clinically important	N/A	15 health professionals	United Kingdom	Qualitative; focus groups and interviews	Children with CFS/ME are impacted across multiple aspects of health
The course of severe chronic fatigue syndrome in childhood; Rangel et al. (2000)	Follow-up of children with CFS after diagnosis	N/A	25 children and adolescents (12–19 years old) and parents	United Kingdom	Semi-structured interviews	Mixture of recovery and still experiencing debilitating symptoms; Factors were found to predict a quicker or more likely recovery
Illness beliefs in CFS: a study involving affected adolescents and their parents; Richards et al. (2006)	Investigate the beliefs of the causes and management of young people with CFS	N/A	21 participants (each with one parent)	United Kingdom	Qualitative; open-ended interviews; content analysis	Virus infection most common cause, psychological problems as a cause was rarely reported. Resting and reducing activity managed symptoms. Positive and negative experiences of psychological treatment

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Cortisol output in adolescents with chronic fatigue syndrome: pilot study on the comparison with healthy adolescents and change after cognitive behavioral guided self-treatment; Rimes et al. (2014)	Investigating cortisol outputs and psychological variables for adolescents with CFS after CBT	CBT through telephone-based–guided self-help	49 adolescents with CFS and 36 healthy adolescents	United Kingdom	Saliva collection (multiple samples). Cortisol measured six months post-treatment. Multiple measures	Daily cortisol output increased significantly after CBT
Cow's milk protein intolerance in adolescents and young adults with chronic fatigue syndrome; Rowe et al. (2016)	Examine illness severity of cow milk's protein intolerance in young people with CFS	Two-year prospective study: pre and post	55 participants (10–23 years old)	United States	Outcome measures at baseline and six months-QOL, Multidimensional Fatigue Scale, Functional Disability Inventory	Thirty-one percentage prevalence of intolerance. Improvement after milk-free diet. Milk-sensitive participants had worse HRQOL at baseline
Myalgic encephalmyelitis/ chronic fatigue syndrome diagnosis and management in young people: a primer; Rowe et al. (2017)	Literature review	N/A	N/A	N/A	Literature review	Overall review of literature in relation to symptoms, possible causes, prevalence and treatment strategies in pediatric population

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
Childhood predictors of self reported chronic fatigue syndrome/myalgic encephalomyelitis in adults: national birth cohort; Viner and Hotopf (2004)	Childhood risk factors for CFS in adults	N/A	16,567 babies born 5–11 April 1970; followed up at 5, 10, 16 and 29–30 years old.	United Kingdom	Childhood data taken from parents and teachers. Maternal mental health examined through malaise inventory	Higher risk of CFS/ME associated with having a chronic condition in childhood, female gender and high social status in childhood. Higher levels of exercise linked to lower risk
Outpatient rehabilitative treatment of chronic fatigue syndrome (CFS/ME); Viner et al. (2004)	To assess the outcome of outpatient multidisciplinary rehabilitative treatment (graded activities/exercise programme, family sessions and supportive care) compared with supportive care alone for children and adolescents with CFS/ME	Multidisciplinary programme (graded activities/ exercise programme, family sessions and supportive care)	56 young people (aged 9–17 years) with diagnosed CFS/ME	United Kingdom	After treatment, participants were followed up for 3–24 months. Primary outcome measures of Global Wellness and school attendance	Significantly higher Wellness scores and school attendance than supportive care alone. Reduction in the overall severity of the illness
What stops children with a chronic illness accessing health care: a mixed methods study in children with CFS/ME; Webb et al. (2011)	Examine factors associated with amount of time it took to access specialist care	N/A	405 children (under 18 years of age)	United Kingdom	Semi-structured interviews; thematic analysis	Inadequate time to assessment/ treatment; medical practioners' lack of knowledge; parents' struggled with communicating CFS for child

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Table 1. (continued)

Title/authors	Objective	Intervention	Participants	Country	Method	Key findings
A feasibility study comparing two treatment approaches for chronic fatigue syndrome in adolescents; Wright et al. (2005)	Feasibility of a larger treatment trial comparing the effectiveness of 'Pacing' versus 'The STAIRway to Health' in adolescents with CFS	Feasibility study	13 participants (age range 8.9–16.9 years)	United Kingdom	Two treatments: 'Pacing' and 'The STAIRway to Health'. Multiple outcome measures: global health; activity, school attendance, fatigue and emotional symptoms	Global health improved in both treatments. STAIRway to Health had a higher rate of improvement

Note: CBT: cognitive behavioral therapy; CFS/ME: chronic fatigue syndrome/myalgic encephalomyelitis; RCT: randomized control trial; ALSPAC: Avon Longitudinal Study of Parents and Children; GET: graded exercise therapy; FITNET: Fatigue in Teenagers on the Internet; HRQOL: Health-related Quality of Life; QOL: quality of life.

Key themes emerging from the search were nutrition and dietary components, exercise therapy, psychosocial factors, and multifaceted treatment strategies. The research findings (see Table 1) within each key theme are discussed in the following.

Nutritional components and therapy

Few studies examined the influence of diet or dietary modifications on alleviating symptoms (Gibson and Gibson, 1999; Rowe et al., 2016). While included as an integral part of a multifaceted treatment, nutritional interventions were also explored separately as an independent factor which could decrease symptoms. Rowe et al. (2016) investigated the impact of cow's milk intolerance in adolescents and young adults (10–23 years old) with CFS/ME as a contributor to gastrointestinal symptoms using mixed methods. Adolescents and young adults with CFS/ME had a higher rate of treatable milk intolerance (31%), compared to recent research presenting 6–7% milk intolerance within children of a healthy population (Boyce et al., 2010). Upon implementation of a six-month milk-free diet in the milk intolerant group, the participants' Health-related Quality of Life no longer significantly differed to the CFS/ME participants who were milk tolerant.

Gibson and Gibson (1999)'s research of a nutritional intervention (wheat-free diet and nutritional supplements (e.g., Co-enzyme Q10, evening primrose oil, magnesium and fluoride) as part of a multifaceted treatment plan) showed a positive impact on improving symptoms after a six-month intervention period. This pilot study presented the first indication that such inclusions of nutritional components could potentially result in a positive impact on the reduction of symptoms for people with CFS/ME.

Harris et al. (2017) used qualitative methods to explore eating difficulties in adolescents (12–17 years old) with CFS/ME. This study found that the eating difficulties commonly experienced by adolescents with CFS/ME were mainly caused by abdominal symptoms, being too tired to eat, and changes in their ability to taste and smell. Psychological symptoms of low mood and anxiety exacerbated these difficulties. Participants expressed interest for interventions through medication and modifying diet, as well as interventions to include families in relation to education in caring for and living with an adolescent with CFS/ME. Furthermore, education and support for those experiencing eating difficulties were one method to ease this experience and thus also decrease the subsequent psychological co-morbidities.

Exercise therapy

Exercise to decrease symptoms of CFS/ME in children under 18 years of age has been explored through various means, for example, graded exercise therapy and progressive resistance training (Gordon and Knapman, 2010; Gordon and Lubitz, 2009). Although exercise has provided both positive and negative results as an effective treatment of CFS/ME in adults (Clark et al., 2017; Larun and Malterud, 2011; Loy et al., 2016; Yoshiuchi et al., 2007), research has shown that cardiovascular exercise and resistance training improve fatigue severity and symptoms of depression in adolescents with CFS/ME (Gordon and Knapman, 2010; Gordon and Lubitz, 2009). Gordon and Lubitz (2009) examined a graded exercise training program for adolescents (mean age: 16 ± 1.25 years) with CFS/ME as part of a four-week inpatient program. Results showed a decrease in fatigue, depression, and mental outlook as a result of the program. Additionally, positive physiological effects (e.g., upper body strength and function improvement) were shown.

These results were similar to graded exercise training results reported in adult studies (Gordon and Lubitz, 2009).

Gordon and Knapman (2010) conducted a randomized control trial (RCT) examining the difference between aerobic graded exercise and progressive resistance training for adolescents (13–18 years old) diagnosed with CFS/ME. Compared to baseline measures, results showed no significant difference between the two intervention types in relation to physical capacity and QOL. However, fatigue severity and symptoms of depression improved for those in the aerobic graded exercise group.

Psychosocial factors

Psychosocial factors were also found to impact diagnosis and increase symptoms of CFS/ME (Lievesley et al., 2014; Parslow et al. 2017a; Rangel et al., 2000; Webb et al., 2011). Psychosocial factors are grounded in a psychological and social context. For example, the psychological impact upon the individual of the disbelief about the condition by healthcare professionals and the social impact of being treated as different and abnormal. Webb et al. (2011) found that living with the condition as a child can prevent access to appropriate treatment as the lack of knowledge of the condition (both carers and doctors) was one barrier to access. In addition, negative attitudes and beliefs concerning the condition in children have shown to reduce timely access to treatment and care for children with CFS/ME (Parslow et al., 2017a; Webb et al., 2011). Recent research on healthcare practitioners' views of the complex nature of the condition and particular aspects of treating/diagnosing children with the condition show the impact having a child with CFS/ME has upon the family, the difficulty in treating symptoms where the child has difficulty in expressing the symptoms and a lack of support from schools in providing a nurturing return to education or environment where the child can work at his/her own pace (Parslow et al., 2017b).

Multiple studies have examined the topic of negative psychological experiences in childhood that could lead to a diagnosis of CFS/ME (Collin et al., 2015; Heim et al., 2006; Viner and Hotopf, 2004). Exploring childhood trauma in relation to an adult diagnosis of CFS/ME, it was shown that through a population study in the United States, childhood trauma was a risk factor for developing CFS/ME in adulthood (Crawley et al., 2013). Furthermore, Collin et al. (2015) explored the risk factor of maternal and childhood mental health in relation to a diagnosis of CFS/ME by 13 years of age. Through parent-completed questionnaires during the antenatal period and regular intervals after birth, this study found that maternal mood (e.g., anxiety, depression) could also be a potential risk factor for childhood diagnosis of CFS/ME (Rowe et al., 2017). However, this was not a clear and direct correlation as diagnosis of CFS/ME could also be a consequence of maternal anxiety and depression altering childhood behaviour, thus creating a risk of developing CFS/ME (Collin et al., 2015).

Rangel et al. (2000) showed no link between gender, age of onset of CFS/ME or symptoms during the worst of their episodes in children with severe CFS/ME and his/her parents over time. However, there was a positive association between low socio-economic status and poor recovery outcome (Rangel et al., 2000). One reason provided was the decreased access to care that could result from having a lower socio-economic status. Other links to poor recovery depended on the timing of the beginning of his/her symptoms (e.g., outside the autumn term) and if it was or was not preceded by a flu-type illness (Rangel et al., 2000).

Multifaceted treatment strategies

A key focus of the research involving children and adolescents with CFS/ME is the examination of interventions to decrease symptoms and improve overall QOL. The interventions reported were cognitive behavioral therapy (CBT), exercise therapy (e.g., graded exercise therapy), dietary amendments and education, and multifaceted therapy (typically included more than one of the above-mentioned intervention types) (Al-Haggar et al., 2006; Ashby et al., 2006; Crawley et al., 2013; Crawley et al., 2017; Gordon and Knapman, 2010; Gordon and Lubitz, 2009; Knight et al., 2013; Lim and Lubitz, 2002; Lloyd et al., 2012; Rimes et al., 2014; Viner et al., 2004; Wright et al., 2005). Key findings presented the positive impact that a multifaceted treatment strategy can have for children with CFS/ME (Al-Haggar et al., 2006; Crawley et al., 2013; Crawley et al., 2017; Gibson and Gibson, 1999; Rimes et al., 2014; Viner and Hotopf, 2004; Viner et al., 2004; Wright et al., 2005).

The multifaceted treatment typically consisted of graded activities and/or exercise programme, CBT, nutritional advice, and in some cases, family sessions (e.g., counselling, education). Research revealed that through comparing multifaceted treatment to supportive care alone, there was a reduction in the severity of the illness, improved school attendance, and higher Wellness scores (Viner et al., 2004). This treatment strategy has shown to increase school attendance and decrease the severity of fatigue for adolescents (Al-Haggar et al., 2006; Ashby et al., 2006; Gibson and Gibson, 1999; Rimes et al., 2014; Viner et al., 2004; Wright et al., 2005). Although there was a positive impact on symptom relief, only two studies were found that examined these treatment programs for those under the age of 10 (Viner et al., 2004; Wright et al., 2005).

CBT was one of the most commonly prescribed psychological therapies used to manage adolescents with CFS/ME (Al-Haggar et al., 2006; Lloyd et al., 2012; Rimes et al., 2014) and deemed the most successful because of its consistent positive impact on overall QOL, school attendance, mood, and symptoms of CFS/ME (Lloyd et al., 2012). CBT was often combined with another therapy tool, for example, the Lightning Process (LP) or biofeedback (Al-Haggar et al., 2006; Crawley et al., 2013; Crawley et al., 2017; Viner and Hotopf, 2004). Crawley et al. (2013, 2017) conducted an RCT of children and adolescents (aged 12–18 years) investigating standard medical care (SMC) which included CBT, compared to SMC plus the LP. Findings showed a decrease in symptoms (e.g., fatigue, physical function, anxiety) over time (6 and 12 months) in the LP plus SMC treatment. As seen in other intervention research, there was also an increase in school attendance by 12 months.

Family sessions were one other inclusion within multifaceted treatment interventions. Viner et al. (2004) showed that including the family sessions within multifaceted treatment (e.g., family sessions, graded-exercise) created a learning tool for the family as well as decreased negative psychosocial influences.

As the positive benefits of a cognitive-behavioral approach have been shown (Al-Haggar et al., 2006; Crawley et al., 2013; Crawley et al., 2017; Knight et al., 2013; Rimes et al., 2014), research has also discussed methods of adapting the treatment through the use of technology. In order to allow increased access to treatment compared to solely face-to-face therapy, telephone-based therapy was examined and shown to be successful in decreasing fatigue and improving school attendance after a six-month follow-up (Lloyd et al., 2012). To increase the uptake and outreach of these programs, the adaption of multifaceted treatment has also led to the development of an Internet-based therapy for adolescents with CFS/ME, which was shown to maintain a similar recovery rate when compared to usual care after a long-term follow-up (1.7– 3.8 years) (Nijhof

et al., 2013). Through these multifaceted interventions, there are common threads of nutrition, exercise, and cognitive-behavioral aspects that are embedded in these approaches.

Discussion

This scoping review has shown the range of peer-reviewed literature exploring nutrition, exercise, and psychosocial factors in managing symptoms of CFS/ME, particularly in adolescents. However, there is a lack of research within these areas investigating younger children, specifically those under 12 years of age. The literature included in this review investigated those under 18 years of age, but this also included studies investigating both adolescents and adults. Only two studies were found to use a multifaceted treatment approach with those of a younger age; however, there were fewer numbers of those of a younger age compared to the adolescents that participated. This may be attributed to a lack of recognition of this condition in children as well as the impact of the social support network prior to and upon diagnosis (e.g., children not being believed or the inability to express their symptoms). There are only a few studies exploring CFS/ME within a prepubescent population and this highlights the need for more research within this age group. In this review, a range of instruments, some validated and non-validated, were used to evaluate outcome measures in the included studies. This highlights the lack of agreement of the best instrument to measure CFS/ME symptoms.

To improve CFS/ME treatment in a pediatric population, there are multiple avenues to further explore. There is insufficient evidence for the use of dietary modifications or the use of nutritional supplements to relieve CFS/ME symptoms in prepubescent children. For instance, there have been few studies, small sample sizes, mostly pilot studies, and the nutritional intervention has more commonly been part of a multifaceted intervention. Further research is warranted in children aged under 18 years through appropriately designed dietary modifications or controlled interventions. Studies with larger and younger populations should be conducted to determine if CFS/ME was the direct cause of dietary intolerance (e.g., the development of milk intolerance). Further research in larger and younger (e.g., prepubescent) samples would provide valuable information to determine if there is and/or should be a difference in nutritional treatment strategies for prepubescent children compared to adolescents. Subsequently, this new knowledge could support the development of new approaches to help reduce symptoms in children with CFS/ME.

In relation to exercise therapy, this review provided positive findings for the benefits of exercise for adolescents with CFS/ME in reducing physical and cognitive symptoms and subsequently improving QOL. There remains the need for further research in those diagnosed with CFS/ME at a younger age and subsequently, the impact of such exercise therapy on their symptoms and QOL. Lastly, the combination of possible psychosocial factors presents a need to conduct more exploratory research to support or disprove developing theories as well as add new possibilities to improve recovery and/or prevent the diagnosis of CFS/ME.

These findings reveal the need for further research to understand the effect that dietary modifications or nutritional interventions, exercise therapy, psychosocial factors and multifaceted treatment could have upon the symptoms of CFS/ME in a prepubescent child. As a result, this could lead to a better understanding of how management strategies within these key areas could inform practice to reduce symptoms and improve QOL of children with CFS/ME.

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References

Al-Haggar MS, Al-Naggar ZA and Abdel-Salam MA (2006) Biofeedback and cognitive behavioral therapy for Egyptian adolescents suffering from chronic fatigue syndrome. *Journal of Pediatric Neurology* 4(3): 161–169.

Arksey H and O'Malley L (2005) Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology: Theory and Practice* 8(1): 19–32.

Ashby B, Wright B and Jordan J (2006) Chronic fatigue syndrome: an evaluation of a community based management programme for adolescents and their families. *Child and Adolescent Mental Health* 11(1): 13–18.

Bakken IJ, Tveito K, Gunnes N, et al. (2014) Two age peaks in the incidence of chronic fatigue syndrome/myalgic encephalomyelitis: a population-based registry study from Norway 2008-2012. *BMC Medicine* 12(1): 167.

Boyce JA, Assa'ad A, Burks AW, et al. (2010) Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID sponsored expert panel. *Journal of Allergy and Clinical Immunology* 126: S1–S58.

Chalder T, Goodman R, Wessely S, et al. (2003) Epidemiology of chronic fatigue syndrome and self reported myalgic encephalomyelitis in 5–15 year olds: cross sectional study. *British Medical Journal* 327: 654–645.

Clark LV, Pesola F, Thomas JM, et al. (2017) Guided graded exercise self-help plus specialist medical care versus specialist medical care alone for chronic fatigue syndrome (GETSET): a pragmatic randomised controlled trial. *Lancet* 390(10092): 363–373.

Collin SM, Norris T, Nuevo R, et al. (2016). Chronic fatigue syndrome at age 16 years. *Pediatrics* 137(2): e20153434–e20153434.

Collin SM, Nuevo R, van de Putte EM, et al. (2015) Chronic fatigue syndrome (CFS) or myalgic encephalomyelitis (ME) is different in children compared to in adults: a study of UK and Dutch clinical cohorts. *British Medical Journal Open* 5(10): e008830.

Collin SM, Tilling K, Joinson C, et al. (2015) Maternal and childhood psychological factors predict chronic disabling fatigue at age 13 years. *Journal of Adolescent Health* 56(2): 181–187.

Crawley E, Hughes R, Northstone K, et al. (2012) Chronic disabling fatigue at age 13 and association with family adversity. *Pediatrics* 130(1): e71–e79.

Crawley E, Mills N, Hollingworth W, et al. (2013) Comparing specialist medical care with specialist medical care plus the Lightning Process® for chronic fatigue syndrome or myalgic encephalomyelitis (CFS/ME): study protocol for a randomised controlled trial (SMILE Trial). *Trials* 14(444): 1–8.

Crawley EM, Emond AM and Sterne JA (2011) Unidentified Chronic Fatigue Syndrome/myalgic encephalomyelitis (CFS/ME) is a major cause of school absence: surveillance outcomes from school-based clinics. *British Medical Journal Open* 1(2): e000252.

Crawley EM, Gaunt DM, Garfield K, et al. (2017) Clinical and cost-effectiveness of the lightning process in addition to specialist medical care for paediatric chronic fatigue syndrome: randomized control trial. *Archives of Disease in Childhood* 0: 1–10.

Gibson SLM and Gibson RG (1999) A multidimensional treatment plan for chronic fatigue syndrome. *Journal of Nutritional and Environmental Medicine* 9: 47–54.

Gordon BA and Knapman M (2010) Graduated exercise training and progressive resistance training in adolescents with chronic fatigue syndrome: a randomized controlled pilot study. *Clinical Rehabilitation* 24: 1072–1079.

Gordon B and Lubitz L (2009) Promising outcomes of an adolescent chronic fatigue syndrome inpatient programme. *Journal of Paediatrics and Child Health* 45(5): 286–290.

Haines LC, Saidi G and Cooke RW (2005) Prevalence of severe fatigue in primary care. *Archives of Disease in Childhood* 90(4): 367–368.

Harris S, Gilbert M, Beasant L, et al. (2017) A qualitative investigation of eating difficulties in adolescents with chronic fatigue syndrome/myalgic encephalomyelitis. *Clinical Child Psychology and Psychiatry* 22(1): 128–139.

Heim C, Wagner D, Maloney E, et al. (2006) Early adverse experience and risk for chronic fatigue syndrome. *Archives of General Psychiatry* 63(11): 1258.

Jenkins M and Rayman M (2005) Nutrient intake is unrelated to nutrient status in patients with chronic fatigue syndrome. *Journal of Nutritional and Environmental Medicine* 15(4): 177–189.

Knight SJ, Scheinberg A and Harvey AR (2013) Interventions in pediatric chronic fatigue syndrome/myalgic encephalomyelitis: a systematic review. *Journal of Adolescent Health* 53: 154–165.

Larun L and Malterud K (2011) Finding the right balance of physical activity: a focus group study about experiences among patients with chronic fatigue syndrome. *Patient and Education Counseling* 83(2): 222–226.

Lievesley K, Rimes KA and Chalder T (2014) A review of the predisposing, precipitating and perpetuating factors in chronic fatigue syndrome in children and adolescents. *Clinical Psychology Review* 34: 233–248.

Lim A and Lubitz L (2002) Chronic fatigue syndrome: successful outcome of an intensive inpatient programme. *Journal of Paediatrics and Child Health* 38: 295–299.

Lloyd S, Chalder T, Sallis HM, et al. (2012) Telephone-based guided self-help for adolescents with chronic fatigue syndrome: a non-randomised cohort study. *Behaviour Research and Therapy* 50(5): 304–312.

Lopez C, Antoni M, Penedo F, et al. (2011) A pilot study of cognitive behavioral stress management effects on stress, quality of life, and symptoms in persons with chronic fatigue syndrome. *Journal of Psychosomatic Research* 70(4): 328–334.

Loy BD, O'Connor PJ and Dishman RK (2016) Effect of acute exercise on fatigue in people with ME/CFS/SEID: a meta-analysis. *Medicine and Science in Sports and Exercise* 48(10): 2003–2012.

Mackenzie C and Wray A (2013) Chronic fatigue syndrome in children and young people. *Paediatrics and Child Health* 23(1): 35–39.

Maes M, Mihaylova I and De Ruyter M (2006) Lower serum zinc in Chronic Fatigue Syndrome (CFS): relationships to immune dysfunctions and relevance for the oxidative stress status in CFS. *Journal of Affective Disorders* 90: 141–147.

Maric D, Brkic S, Mikic AN, et al. (2014) Multivitamin mineral supplementation in patients with chronic fatigue syndrome. *Medical Science Monitor* 20: 47–53.

Nacul LC, Lacerda EM, Pheby D, et al. (2011) Prevalence of myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) in three regions of England: a repeated cross-sectional study in primary care. *BMC Medicine* 9: 91.

Nijhof SL, Maijer K, Bleijenberg G, et al. (2011) Adolescent chronic fatigue syndrome: prevalence, incidence, and morbidity. *Pediatrics* 127(5): 1169–1175.

Nijhof SL, Priesterbach LP, Uiterwaal CSPM, et al. (2013) Internet-based therapy for adolescents with chronic fatigue syndrome: long-term follow-up. *Pediatrics* 131(6): e1788–e1795.

Parslow RM, Harris S, Broughton J, et al. (2017a) Children's experiences of chronic fatigue syndrome/myalgic encephalomyelitis (CFS/ME): a systematic review and meta-ethnography of qualitative studies. *British Medical Journal Open* 7(1): e012633.

Parslow RM, Shaw A, Haywood KL, et al. (2017b) Important factors to consider when treating children with Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME): perspectives of health professionals from specialist services. *BMC Pediatric* 17(1): 43.

Rangel L, Garralda M, Levin M, et al. (2000) The course of severe chronic fatigue syndrome in childhood. *Journal of the Royal Society of Medicine* 93: 129–134.

Richards J, Chaplin R, Starkey C, et al. (2006) Illness beliefs in chronic fatigue syndrome: a study involving affected adolescents and their parents. *Child and Adolescent Mental Health* 11(4): 198–203.

Rimes KA, Goodman R, Hotopf M, et al. (2007) Incidence, prognosis, and risk factors for fatigue and chronic fatigue syndrome in adolescents: a prospective community study. *Pediatrics* 119(3): 603–609.

Rimes KA, Papadopoulos AS, Cleare AJ, et al. (2014) Cortisol output in adolescents with chronic fatigue syndrome: pilot study on the comparison with healthy adolescents and change after cognitive behavioural guided self-help treatment. *Journal of Psychosomatic Research* 77(5): 409–414.

Rowe PC, Marden CL, Jasion SE, et al. (2016) Cow's milk protein intolerance in adolescents and young adults with chronic fatigue syndrome. *Acta Paediatrica* 105(9): e412–e418.

Rowe PC, Underhill RA, Friedman KJ, et al. (2017) Myalgic encephalomyelitis/chronic fatigue syndrome diagnosis and management in young people: a primer. *Frontiers in Pediatrics* 5: 121.

Tricco AC, Lillie E, Zarin W, et al. (2018) PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine* 169(7): 467–473.

Viner R and Hotopf M (2004) Childhood predictors of self reported chronic fatigue syndrome/myalgic encephalomyelitis in adults: national birth cohort study. *British Medical Journal* 329(7472): 941–950.

Viner R, Gregorowski A, Wine C, et al. (2004) Outpatient rehabilitative treatment of Chronic Fatigue Syndrome (CFS/ME). *Archives of Disease in Childhood* 89: 615–619.

Webb CM, Collin SM, Deave T, et al. (2011) What stops children with a chronic illness accessing health care: a mixed methods study in children with Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME). *BMC Health Service Research* 11(1): 308.

Wright B, Ashby B, Beverley D, et al. (2005) A feasibility study comparing two treatment approaches for chronic fatigue syndrome in adolescents. *Archives of Disease in Childhood* 90(4): 369–372.

Yoshiuchi K, Cook DB, Ohashi K, et al. (2007) A real-time assessment of the effect of exercise in chronic fatigue syndrome. *Physiology and Behavior* 92(5): 963–968.