

Early Childhood Education Teachers' Nutrition Knowledge For 2-5-Year-Old Children in Childcare: A Narrative Review

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Abstract

Caregivers' nutrition knowledge is important for children's health and preventing childhood obesity. Our aim was to review evidence for early childhood education (ECE) teachers' nutrition knowledge for pre-schoolers in childcare. Article searches were conducted from March 2016 to July 2020 across three databases and were considered eligible if published in English up to July 2020 and related to ECE teachers' nutrition knowledge. Of the articles that met inclusion criteria (n=19), nine directly measured ECE teachers' nutrition knowledge for pre-schoolers and three directly measured ECE teachers' general nutrition knowledge. All articles except one provided data for ECE staff nutrition-related attitudes, beliefs and/or behaviours. Studies were non-experimental, descriptive, cohort and/or cross-sectional, with one randomised control trial (RCT); all but one study used questionnaires to measure outcomes. Most studies suggested ECE teachers lack nutrition knowledge, but further research is warranted.

Keywords: Teachers' Nutrition Knowledge; Childhood Obesity; Pre-Schooler; Childcare; Nutrition Training; Nutrition Attitudes

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Introduction

Recent trends predict that over 70 million infants and young children worldwide will likely be overweight and obese in 2025 [1]. A systematic review and meta-analysis showed that obese children were about five times more likely to be obese in adulthood than children with a healthier weight [2]. This anticipates enormous burden on already stretched healthcare structures [3,4]. With more children being enrolled in early childcare education (ECE) centres [5-7], this environment is highly important for children's health, particularly with regards to body weight [8-11]. Despite mixed evidence [12,13], longitudinal and observational research report that children who attend childcare are more likely to be overweight [14-16]. Several obesogenic characteristics have been identified in childcare, such as limited nutrition and physical activity policies [17-19], and lack of outdoor and/or indoor play space for physical activity [20-24]. Although more research is needed [14,19], these characteristics are likely contributing to current obesogenic behaviours in children, such as increased screen-use, low physical activity and poor diets [25,19], which are associated with higher disease risk factors, such as hypertension, insulin resistance [26,27] and increased body fat mass [24].

One aspect of the childcare environment that remains particularly unreported is the status and role of ECE teachers' knowledge about nutrition for pre-schoolers (2-5-year-olds) in childcare. This is

disconcerting with research suggesting ECE teachers' knowledge may affect the health and behaviour of children [28,29]. Moreover, lack of enquiry would be an inappropriate response to current global strategies that now recognise the importance of caregivers' health knowledge [30] and their understanding of the links between health, diet and physical activity for children's health [31]. In New Zealand, the revised *Te Whāriki - Early Childhood Curriculum* also advocates that child carers be frequently informed about nutrition and physical activity for children and teach these as part of early learning curriculum [32].

Over the past 30 years, relatively few studies have investigated ECE teachers' nutrition knowledge for pre-schoolers [28,33-39]. To the authors' knowledge, there are no literature reviews specifically reporting ECE teachers' nutrition knowledge for pre-schoolers. Therefore, the purpose of this narrative review was to address this gap in the literature and provide a summary and appraisal of published articles for what ECE teachers know about nutrition for pre-schoolers. This up-to-date review on the current evidence should be a source of information for those interested in improving ECE teacher nutrition knowledge and child health. It was hypothesised that ECE teachers' lack nutrition knowledge for pre-schoolers and that this would be supported by limited evidence.

Key Messages

- This is the first narrative review of ECE teachers' nutrition



knowledge for pre-schoolers.

- Most studies suggested ECE teachers lack nutrition knowledge, yet few studies have used validated tools to accurately assess this knowledge.
- Ensuring that ECE teachers have the nutrition knowledge to support children's healthy eating is important for improving child health within the ECE environment.

Methods

This study followed available steps for writing a non-systematic narrative literature review and guidance for writing scientific manuscripts [40-42]. To align with recent New Zealand research, we defined ECE centres to include any group-based education and childcare setting for under 5-year-olds (e.g. day cares, nurseries, pre-schools, and kindergartens) [43]. No ethical approval was required as this review examined existing literature.

Search Procedure

The authors searched the credible databases MEDLINE/PubMed, Scopus and Google Scholar [42] using specific search terms in various combinations. These terms were derived from the aim of the review and medical subject headings (MeSh) or tag words from relevant papers (Table 1). Our preliminary search of the literature endeavoured to establish the need for a review of ECE teachers' nutrition knowledge for pre-schoolers and to refine the topic and objectives. Despite efforts to refine searches, some results were excessively large and mostly irrelevant, and to screen all items was deemed extraneous for this narrative review. Therefore, a particularly relevant article was selected from these search results and then a link to similar articles was followed until a point of data saturation was experienced (e.g. studies appeared

repeatedly across searches or studies). Additional references were identified by manually screening reference lists of relevant articles. To find the most recent literature, filters for specific time frames (e.g. past 5 years) were applied. Using key filters, search terms and links to related articles provided some search logic to improve search objectivity and to optimise article retrieval [40]. Searches were conducted March 2016 through July 2020, with articles published up to July 2020 included in this review.

Search terms, and inclusion and exclusion criteria. The date searched, inclusion criteria, search terms, search terms that returned more focused results, search filters applied, and electronic databases used are shown under the corresponding sub-headings within the text box.

Inclusion and Exclusion Criteria

An article was considered if it met the criteria listed in Table 1. All types of study designs were permitted if they offered qualitative and/or quantitative data for ECE teachers' nutrition knowledge. To minimise the loss of useful data, we did not limit the inclusion of articles to ECE teachers' nutrition knowledge specifically for pre-schoolers but also considered papers reporting ECE teachers' general nutrition knowledge and/or nutrition-related attitudes, beliefs and behaviours, since these may provide insight into nutrition knowledge [39,44, and 45]. Broadening our search in these ways was particularly important given the scarcity of available literature and preliminary nature of this review. A critical assessment of the articles was conducted following suggestions by Ferrari R (2015) [41]. With regards to eligibility, no further information from authors was pursued.

Results

Summarising the Articles

Table 2 summarises 19 articles identified in this literature review that provide information about ECE teachers' nutrition knowledge. Of these, nine studies directly measured ECE teachers' nutrition knowledge for pre-schoolers [28,33,35-37,39, and 46-48], and four studies directly measured ECE teachers' general nutrition knowledge [44,49-51]. The remaining six studies focused on ECE teachers' nutrition-related attitudes, beliefs and/or behaviours, which could be reflective of teachers' nutrition knowledge [17,18,34,38, and 52-54]. Fourteen studies used questionnaires to measure outcomes, with one [34], of these using additional focus groups; the remaining study [52] used semi-structured interviewing. Most (n=14) of the studies were conducted in the United States of America (US) [28,33-37,39,46,48-51,53, and 54], one in New Zealand [17,18], one in Australia [44], one in Canada [52] and one in the United Kingdom (UK) [38]. No meta-analysis and systematic reviews were found; studies included were non-experimental, descriptive, cohort and/or cross-sectional, with one randomised control trial (RCT) [33]. Earlier studies (1970s and 1980s) focused more on ECE teachers' nutrition knowledge for pre-schoolers, with one study [39] providing detailed information about ECE teachers' beliefs and behaviours. More recent studies, although reported on ECE nutrition knowledge, attitudes, beliefs and/or behaviours, focused on other objectives, such as investigating policies, barriers for nutrition in childcare and/or the effectiveness of nutrition programmes.

ECE Teachers' Nutrition Knowledge

A lack of nutrition knowledge in ECE teachers was apparent across all articles in this review, with seven studies specifically reporting low objectively measured nutrition knowledge scores amongst

Table 1: Search terms, and inclusion and exclusion criteria.

Date searched: March 2016 - July 2020
Inclusion criteria
Written in English only
Published up to July 2020
ECE teachers in ECE childcare centres
Outcomes of ECE teachers' nutrition knowledge
Exclusion criteria:
Not in English
Published after July 2020
Full-text unavailable
Articles without outcome measures for ECE teachers' nutrition knowledge
Search terms
child care centre OR childcare OR child care OR child-care OR daycare OR day care OR day-care OR kindergarten OR preschool OR pre-school OR nursery OR nurseries OR elementary OR caregiver
AND nutrition, diet, feeding
AND teacher
AND knowledge
AND review
Search terms that returned more focused results
PubMed: child, preschool OR child day care centers OR child day care centres AND nutrition knowledge
Scopus: nutrition knowledge AND teacher
Google Scholar: child care AND teacher AND nutrition knowledge
Filters: past 5 years, past 10 years
Electronic Databases: MEDLINE/PubMed, Scopus, Google Scholar



Table 2: Characteristics of the studies included in this review.

Authors* (year)	Country	Design	Sample	Purpose	Validated NK questionnaire	Relevant outcome measures	Relevant findings
Halloran KM, et al. (2018) [46]	US	Cross-sectional	n=85 head start teachers	To examine the association between NK, attitudes, and fruit/vegetable intake and teacher mealtime behaviours	Partial	NK/beliefs for pre-schoolers	NK high with overall mean 9.80 (SD 1.96); range, 3.0-12.0. Median nutrition attitude scores 72.87 (interquartile range, 70-75)
Liu H, et al. (2018) [47]	China	Cross-sectional	n=222	Assess NK, attitudes and practices	Partial	NK/beliefs for pre-schoolers	Knowledge deficits: 54.2% familiar with simple NK; 9.9% satisfied with their NK; 97.7% had positive attitude to learn NK
Rida Z, et al. (2018) [48]	US	Cross-sectional	n=398	Assess NK related to Child and Adult Care Food Program meal pattern	Partial	NK for pre-schoolers	Overall mean correct score was 70% (19 correct responses out of 27 questions); scored low on yoghurt (30%), juice (35%), breakfast cereal (37%), and whole grain (43%) questions
Gerritsen S, et al. (2016) [17], Gerritsen S, et al. (2016) [18]	NZ	Cross-sectional	n=257 managers/head teachers of licensed ECE centres	To describe nutrition environments in formal childcare for 3-4-year-olds	No	NK/practices for pre-schoolers	Knowledge deficits evident in nutrition policies. Largely high sugar, salt and/or saturated fat foods at celebrations (some weekly) and sold for fundraising; >50% of centres had not gained HHA (n=29; 58% of centres enrolled)
Jones AM, et al. (2015) [37]	US	Observational	n=102 pre-kindergarten to 12 th grade teachers	To determine resources used, barriers, & NK/nutrition taught links	Yes	NK/beliefs for pre-schoolers	Teachers unaware of nutrition resources NK scores ranged from 5 to 53 of a maximum possible of 58 (n=85); mean score 35.6 (SD 10.3)
Alkon A, et al. (2014) [33]	US	RCT (7 months)	n=17 licensed ECE centres; 90 staff went to workshops	To evaluate impact of NAP SACC intervention	No	NK/practices for pre-schoolers	Providers' healthy eating knowledge pre-test mean 2.05 (SD 0.67) of a range of 0-4; post-test mean 3.63 (SD 0.56); this was a significant increase (P<0.0001)
O'Dea JA (2016) [44]	AUS	Cohort	n=23 primary school teachers; 301 Years 5 and 6 school children	To examine change in nutrition and PA knowledge, efficacy, behaviours and attitudes after a nutrition programme	Validation not outlined	General NK/attitudes	Teachers' nutrition NK significantly improved (P<0.0001); from 24.27 (SD 4.89) to 51.0 (SD 5.61). Teachers attitudes towards the importance of nutrition and self-efficacy to teach nutrition increased significantly (P<0.01). Baseline: 13.3% teachers felt very confident to teach nutrition; 66% a little confident; 66.7% teachers believed health and nutrition were important and 26.7% said very important.
Sharma S, et al. (2013) [50]	US	Cross-sectional	n=176 Head Start teachers	To describe the nutrition-related knowledge, attitudes and behaviours among Head Start teachers	No	General NK/beliefs	None answered all five nutrition items correctly; food groups to be consumed most, foods groups to be consumed least, daily servings fruits and vegetables, daily fat recommendations, macronutrient with most calories (10%, 68%, 39%, 8 %, 48%, respectively). Teachers agreed with: being overweight increases health risks (75%); it is difficult to know what nutrition information (54%); 79% teachers were obese; weight-loss practices in >70% teachers.
Lanigan JD (2012) [28]	US	Longitudinal	n=72 child care providers from 45 ECE settings	To examine nutrition-related child care provider practices, knowledge and beliefs	Validation not outlined	NK/practices for pre-schoolers	Misconceptions (mean score 9.4 (SD 2.8) baseline, mean score 9.3 (SD 2.3) n=72; no significant change. Feeding knowledge baseline mean score 13.9 (SD 2.8), follow-up mean score 12.3 (SD 1.9; significant change P<0.01) n=72; scores ranged from 5-20. Improvements in nutrition education correlated significant with changes in providers' efficacy (r=0.68; P<0.01), misconception (r=0.51; P<0.01), feeding knowledge (r=0.35; P<0.05) and priority placed on children's healthy eating (r=0.26; P<0.05).
Lynch M, et al. (2012) [52]	Canada	Cross-sectional	n=13 formal, licensed ECE providers	To understand the strategies childcare providers perceive to encourage healthy eating in childcare settings	n/a (used semi-structured interviewing)	Beliefs/practices for pre-schoolers	Positive and negative nutrition-related beliefs/behaviours



Sigman-Grant M, et al. (2011) [53]	US	Observational	n=203 ECE directors and 567 staff	To compare self-reported feeding practices at ECE centres CACFP-funded versus non-funded centres)	Yes	Feeding practices for pre-schoolers	CACFP-funded centres reported more supportive feeding practices than non-funded centres for 10 of 26 practices; widespread positive feeding practices evident. Strategies included role modelling, teaching, coaxing and restriction.
Derscheid LE, et al. (2010) [34]	US	Mixed-mode descriptive (quantitative & qualitative)	n=360 ECE staff (includes 32 ECE teachers)	To identify early childhood professionals' perceptions and knowledge about healthy habits		NK/beliefs for pre-schoolers	Responses for 5 of 18 survey items significantly differed by education levels (e.g. higher NK correlated with more positive beliefs); years of experience significantly differed on 3 items (e.g. less experienced agreed government nutrition guidelines useful). Positive teacher nutrition beliefs/behaviours. Teachers perceived lack of resources; identified nutritionist as their source of ideas for teaching nutrition.
Freedman MR, et al. (2010) [35]	US	Observational	n=72 ECE providers (licensed/non-licensed); 50 completed NK tests	To examine child feeding attitudes, practices and knowledge of multi-ethnic ECE providers (pre-post a 90-minute nutrition class)	Yes	NK/attitudes/practices for pre-schoolers	Increase in child feeding knowledge from 73% correct (pre-test) to 82% (post-test); increased knowledge on 5 of 13 items; knowledge not always matching behaviour. Many positive attitudes and practices (e.g. "I turn the TV off during mealtimes"); some negative, e.g. only 24% Hispanic providers reported eating meals together with children, compared to all whites and most (86%) Asians (P<0.05). Those with more education were more likely to eat with children (P<0.05).
Trost SG, et al. (2009) [54]	US	Cross-sectional	n=297 registered family childcare homes	To describe policies and practices related to nutrition and PA	Yes	Feeding practices for pre-schoolers	Positive practices: most providers served enough fruit and vegetables daily; few served fried meats/unhealthy foods regularly; most reported eating meals with children; almost none reported routinely using treat foods as a reward for behaviour or withholding food as punishment. Negative practices (e.g. infrequent (<14%) servings of low-fat milk; frequent use of unhealthy foods for celebrations). <50% received regular nutrition training.
Moore H, et al. (2005) [38]	UK	Mixed-mode descriptive (quantitative/qualitative)	n=168 ECE registered providers	To investigate the food offered to under-5's in childcare & nutrition-related ECE provider attitudes/roles	Validation not outlined	NK/beliefs for pre-schoolers	Positive nutrition-related beliefs. Providers strongly agreed (5%), slightly agreed (21%) and disagreed slightly (25%) that parents were responsible to meet dietary needs. About 25% did not find government guidance on nutrition useful or did not have a view; NK gained from peers/family. Staff with some training were more able to identify importance of dietary components (e.g. carbohydrates).
Nahikian-Nelms M (1997) [39]	US	Non-experimental	n=113 caregivers in 24 licensed childcare programs	To measure the NK and attitudes of caregivers in childcare programs and to observe the behaviours of caregivers as they interact with children at mealtime	Yes	NK/attitudes/behaviours for pre-schoolers	High mean scores for attitudes (69 out of 81 points); low scores for NK (10.9 out of 20 points); mean score for behaviour was 6.59 out of 10 possible points. NK item scores: <50% teachers answered 10 of NK questions correctly; RDA, nutrients (iron, vitamin A), food groups (13%, <50%, <50% correct answers, respectively); 40% knew the recommended fruit and vegetable servings; 19% correctly related intake of sugar to tooth decay; 49% did not know how much of a child's nutrition needs should be met in childcare. >70% had attitudes that met feeding recommendations (e.g. sitting with children during meals to model good eating habits); negative attitudes present (e.g. 14.2% agreed with using food as rewards). Positive correlation (r=0.18, P=0.04) between caregivers' NK and behaviour at mealtime; years of teaching experience positively correlated with caregiver mealtime behaviour (r=0.10, P=0.03). Level of education predicted NK; highest NK scores were more likely to score highest for attitudes (full model not significant). No correlation between previous nutrition training and caregivers' nutrition attitudes or behaviour. Used out-dated resources/text-books.



Petersen ME, et al. (1972) [49]	US	Cross-sectional	n=910 early elementary teachers	To measure NK and attitudes of early elementary teachers	No	General NK/ attitudes/ practices	NK scores were low, greater tendency to score higher on general knowledge items and lower on those related to food composition. Poor relationships between knowledge scores, attitudes, and teaching nutrition.
Gillis DE, et al. (1980) [36]	US	Cross-sectional	n=120 day care teachers	To gain a perspective on the status of the day care teacher as an active proponent of good nutrition	Yes	NK for pre-schoolers	NK was low; Mean (SD) overall NK score 10.9 (3.1) out of a possible score of 20. Opinions on the importance of nutrition were positive. Backgrounds in ECE or previous nutrition training did not predict NK; those with ECE degrees/diplomas used food more frequently in learning activities.
Soliah LA, et al. (1983) [51]	US	Cross-sectional, descriptive	n=819 elementary teachers	To assess NK, attitudes and practices of elementary teachers	Yes	General NK/ attitudes/ practices	Higher qualifications or were teaching nutrition had higher scores on NK, attitudes and practices. NK scores positively correlated with attitudes and practices; they had favourable attitudes (e.g. almost all believed nutrition should be taught in elementary school); few teachers taught nutrition concepts.

*Some publications reported on the same study and are therefore clustered in one cell.

Note: Studies are organised by publication date.

Abbreviations: NK: nutrition knowledge; NZ: New Zealand; ECE: early childhood education; HHA: Healthy Heart Award; US: United States of America; SD: standard deviation; RCT: randomised control trial; NAP SACC: Nutrition and Physical Activity Self-Assessment for Child Care; AUS: Australia; PA: physical activity; r: Pearson's product-moment correlation coefficient; n/a: not applicable; CACFP: Child and Adult Care Food Program; UK: United Kingdom; RDA: recommended dietary allowance.

ECE teachers [35,36,39,47-49, and 51]. Jones AM, et al. (2015) [37], reported an average nutrition knowledge score of 61.4% amongst ECE teachers. This was considered “less than ideal” as questions related to current dietary recommendations, nutrients, and diet-disease links that teachers would be expected to have understood well. Sharma S, et al. (2013) [50], reported that out of 176 ECE teachers, only four teachers (3%) answered at least four out of five nutrition-related questions correctly, 27 teachers (18%) answered at least three correctly and no teacher was able to answer all five correctly. Three of these questions asked about basic food groups in relation to adult nutrition guidelines (e.g. “How many servings of fruits and vegetables should you eat per day?”), while two asked about recommended daily intake (RDI) values (e.g. “What percent of your daily calories should come from fat?”). In New Zealand, a recent study of 257 ECE centres reported that staff demonstrated nutrition knowledge deficits when nutrition policies misaligned with current food and nutrition guidelines, for example, it was found that some policy statements permitted regular provision of high sugar, salt and/or saturated foods and beverages (e.g. instant noodles, milo, cordial, full-fat milk) [18]. Furthermore, three studies indicated that most ECE teachers did not know about and/or perceived a lack of nutrition resources [34,37, and 39].

Four studies reported ECE teachers' nutrition knowledge deficits before and after exposure to a nutrition intervention, with all showing significant improvements in teachers' nutrition knowledge at follow-up [28,33,35, and 44]. In Australia, O'Dea JA (2016) [44], reported elementary school teachers' overall nutrition knowledge mean score doubled and each nutrition knowledge variable showed an improvement from baseline to follow-up ($P < 0.0001$) after exposure to the *Nestlé Healthy Active Kids*, which is an online Australian programme providing teachers with free resources to support children's healthy eating and active lifestyles [55]. Questionnaire items related to basic nutrition concepts, such as, “Can you name the 5 food groups?” and “Can you name 1 key nutrient provided by each Food Group?”. More challenging questions were included, such as “Can you draw the level of the human body and the brain that is made up of water (on the diagrams below?)” [44]. Although it was shown that low baseline knowledge in

students predicted their knowledge gain, knowledge gains in teachers did not predict any independent variables in children. Nevertheless, the intervention led to several improvements in children's dietary behaviours, for example, 89.1% of children reported “drinking more water each day” post-intervention. It was concluded that although basic nutrition knowledge was important for both teachers and students, other factors such as self-efficacy, empowerment and skill development were vital for behaviour change in children. Meanwhile, a seven-month RCT in the US reported an improvement ($P < 0.0001$) in childcare staff's overall nutrition knowledge scores post-intervention (after nutrition workshops) [33]. Although there were no corresponding significant changes in eating behaviours or children's healthy lunches, a trend toward serving healthier lunches was observed in the intervention versus control centres, for example, an 8% increase in healthy foods offered in intervention centres compared to a 1% increase in control centres. Decreases in children's age- and sex-specific standardised body mass index (zBMI) and significant improvements in centre policies were also observed in the intervention centres.

Two studies reported objectively measured knowledge deficits amongst ECE teachers towards feeding practices at baseline. Lanigan JD (2012) [28], found particular feeding practice knowledge deficits towards the importance of child involvement in meal preparation, eating the same food as children, sitting with children at mealtimes, honouring children's satiety cues and/or respecting children's food preferences. Misconceptions about using food as a reward, children's ability to self-regulate food intake and a notion that society had gone overboard limiting sweets were also reported. Freedman MR, et al. (2010) [35], found that before exposure to the intervention (a 90-minute interactive class on feeding responsibility), 48% of childcare providers correctly answered “false” that dessert should be used as a reward, 46% knew that children should self-regulate food intake and 48% knew that it is not okay to cook only meals children liked in order to manage picky eaters. After attending a nutrition class, these teachers showed a significant improvement in knowledge about using dessert as a reward, if children should self-regulate food intake, if children should be forced to finish eating everything on their plate, have regular meals and snacks



and be allowed to eat only preferred foods to ensure food intake. No follow-up was conducted to assess knowledge retention or behaviour change, however, it was found that knowledge did not always translate into behaviour during the study, for example, >90% of respondents identified that a child may need to try a food many times before he or she likes it, yet 59% of all providers were forcing children to finish everything on their plate before dessert (rather than allowing children the option to only try a food).

ECE Teachers' Nutrition-Related Attitudes and Beliefs

Eleven of the 19 articles reported favourable nutrition-related attitudes and/or beliefs in ECE teachers [34,35,37-39,44,46,47, and 49-51]. O'Dea JA (2016) [44], showed that at baseline, 66.7% of teachers believed health and nutrition were important and 26.7% believed this to be very important. The latter increased to 60% after their involvement in the *Healthy Active Kids* programme which included a teacher professional development day [55]. Three US studies showed ECE teachers believed in the important link between nutrition and child health [34,38, and 50]. Specifically, teachers generally believed both physical activity and nutrition is essential for overall health [34], and 93% of teachers agreed that learning the relationship between nutrition and health was important [50]. Moore H, et al. (2005) [38], reported that 64% ECE teachers strongly agreed and 20% agreed slightly that diets early in life have long-term health effects. A sense of responsibility to promote health to children and widespread awareness for the need to promote fruits and vegetables to children was also found amongst these teachers, yet, 5% strongly agreed, 21% slightly agreed and 25% disagreed slightly that it is the parents' responsibility to meet children's dietary needs. Two studies found that ECE teachers believed they had a role to model nutritional concepts throughout the day and that mealtime or involving children in meal preparation encouraged children to learn about nutrition and try new foods [34,39]. Lynch M, et al. (2012) [52], found ECE teachers believed that it is important to not use pressure techniques to get children to eat food and that the look of food (e.g. if food looks fresh or recognisable) was vitally important to improve food acceptance, especially for children with particular sensitivities to food characteristics (e.g. textures, colours). Two studies demonstrated positive attitudes towards nutrition teacher education [37,47], with recent findings in China found at least 94% were willing to attend nutrition training [47].

The ECE teachers also demonstrated negative nutrition-related attitudes and beliefs, for example, 14.2% of the caregivers agreed that promising a dessert or another treat encourages children to try new foods [39]. Sigman-Grant M, et al. (2011) [53], found at least two-thirds of childcare staff believed role modelling, teaching, coaxing and restriction are effective strategies for getting children to try new foods. Lynch M, et al. (2012) [52], found many providers believed that to get children to eat healthily, caregivers needed to disguise less preferred foods, dilute sugary drinks or add ketchup, cheese and dips and offer dessert as a reward. Their study reported that when children were hungry soon after lunch, providers used phrases such as "If you ate better at lunch then you would have enough to keep you", or that snack time is "not for a few more hours this is why you should eat all your food at lunchtime, so you won't be starving". Furthermore, three studies suggested that ECE teachers' lacked confidence about their nutrition knowledge and skills [44,50, and 56].

ECE Teachers' Nutrition-Related Behaviours and Feeding Practices

Twelve of the 19 articles reported ECE teachers' nutrition-related

behaviours and/or feeding practices [17,18,28,33,35,39,46,47,49, and 51-54]. Gerritsen S, et al. (2016) [17], found most centres promoted some healthy eating behaviours, for example, 25% of centres in their study were involved in the *Healthy Heart Award* programme (which strives to promote and create a healthy eating environment) [57], yet more than 50% had not yet achieved the award. Three studies found unhealthy foods were commonly served in childcare centres on special occasions and/or sold for fundraisers [52,54, and 58], with some childcare centres providing a special treat day (e.g. Fridays) that entail several treat foods (e.g. cookies) [52]. Trost SG, et al. (2009) [54] found, despite some positive practices, only 23% reported serving meals family style (e.g. eating together at the table) and less than 50% celebrated special occasions with healthy or non-treat foods. Freedman MR, et al. (2010) [35], showed that 59% of all providers insisted children finished all the food on their plate before dessert and that some practices were more prevalent in certain ethnic groups, for example, greater than 85% Hispanic providers reported forcing children to eat food they thought is good for them, compared to 59% Asians and 44% whites. It was also found that those with some college education were more likely to practice some positive feeding practices, such as eating with children. More recently, Gerritsen S, et al. (2016) [18], found 49.6% of the staff always talked to children in childcare about what they were eating, or asked if children were full before offering a second helping of food.

In contrast, three studies reported positive behaviours and feeding practices [34,35, and 53]. For example, despite a tendency for *Child and Adult Care Food Program* (CACFP)-funded centres to report more supportive feeding practices than non-funded centres, 90% of childcare staff from both types of centres in the US noticed and commented on (90%) and praised (95%) children who were eating well [53]. Most (87%) reported never using food as a bribe or for consolation. Freedman MR, et al. (2010) [35], reported other positive behaviours, such as 63 out of 70 ECE teachers reported turning off the television during meal times. Other US ECE teachers reported sitting with children during mealtimes four times per day [34]. Meanwhile, Halloran KM, et al. (2018) [46], observed higher scores indicating more optimal mealtime behaviours among Head Start teachers (mean 91.93; SD, 4.77; range, 82.101), but the occurrence of specific practices such as enthusiastic role modelling of healthy eating, pressure to eat and responding to children's hunger and fullness cues were not described.

ECE Teachers' Background and Nutrition Knowledge/Attitudes/Practices

Eight studies indicated that ECE teachers' educational background predicted nutrition knowledge, attitudes and/or practices [28,34,35,38,39,46,47, and 51]. For example, there was a statistically significant relationship ($r=0.27$, $P=0.003$) between their level of education and nutrition knowledge [39]. It was reported that compared to those with higher qualifications (e.g. bachelor's degree), ECE professionals in the US with lower education levels (e.g. high school diploma) were more likely to strongly agree that it is difficult to persuade children to try healthy foods [34]. Similarly, years of experience was shown to be positively correlated with nutrition-related perceptions [34] and behaviours [39]. Furthermore, two early studies found a positive relationship between nutrition knowledge and attitudes and/or practices [39,51]. More recently, Liu H, et al. (2018) [47], identified several factors that influence nutrition knowledge for pre-schoolers, including professional teacher training or having attended a childhood nutrition knowledge course. Meanwhile two studies showed that previous nutrition training did not predict nutrition knowledge [36,39]. In Halloran KM, et al. (2018) [46], a positive association between



teaching experience and meal-time behaviour, but the relationship between experience and nutrition knowledge seemed not fully explored.

Discussion

The purpose of this narrative review was to identify and summarise what is known about ECE teachers' nutrition knowledge for pre-schoolers (2-5-year-olds). This review has identified:

- Nutrition knowledge deficits in ECE teachers, and
- Scope to further investigate and improve ECE teachers' current nutrition knowledge for pre-schoolers.

Results of this review suggest a general lack of nutrition knowledge in ECE teachers that has persisted over time. Of the articles that provided quantitative data, researchers either interpreted mean scores for ECE teachers' nutrition knowledge to be low [35-37,39,47-49, and 51], or reported significantly improved nutrition knowledge scores after nutrition training was provided for teachers [28,33,35, and 44]. The latter implies that ECE teachers had initially low or limited nutrition knowledge and that this would likely continue without appropriate nutrition education. There was only one paper that reported high nutrition knowledge scores, but results were limited by the use of a partially validated nutrition knowledge questionnaire. Overall, there is considerable variation across studies (e.g. not all studies tested the same nutrition concepts), thus while ECE teachers may generally lack nutrition knowledge for pre-schoolers, exact levels are unclear.

ECE teachers may lack basic nutrition knowledge relating to main food groups and key nutrients. It was shown that only 10% of a sample of US ECE teachers knew which food group should be consumed the most [50]. Meanwhile, Australian teachers scored lower on the key nutrients and the five food groups before exposure to a nutrition programme, compared to after exposure [44]. This was consistent with early [39,49] and recent [47] research that showed few ECE teachers were knowledgeable about food groups and nutrients, which suggests knowledge deficits towards basic nutrition concepts have persisted over time. It is not currently possible to identify specific food groups or nutrients that ECE teachers, in general, consistently lack knowledge about. This may be expected if teachers are exposed to variable nutrition training programmes and policies [43] that may increase the likelihood of ECE teachers gaining different knowledge and skill sets. Moreover, if knowledge deficits towards specific topics vary between providers then programmes should be tailored accordingly - a strategy increasingly being advocated [59-63].

Compared to knowledge scores for basic food groups and nutrients, ECE teachers tend to score lower on items about recommended dietary intake (RDI) values. It was shown that only 8% of teachers knew about the recommended percentage of daily calories from fat, compared to 68% who knew that fats and oils should be consumed the least [50]. This trend was similar in early research, with fewer teachers knowing about RDI values and how to apply them (19%), compared to knowing about the recommended fruit and vegetable servings (40%) [39]. This suggests ECE teachers have found some nutrition concepts (e.g. RDI values) more challenging than other areas (e.g. food groups) for some time. This is not surprising if teachers rely on gaining knowledge from public nutrition resources (e.g. My Plate) which tend to emphasise the recommended servings from food groups, rather than specific RDI values [64-66]. Moreover, research shows that nutrition information panels and RDI values are less well understood by the general public, as this demands greater numeracy and literacy skills to interpret [67,68]. If nutrition resources do not currently emphasise RDI values and ECE

teachers continue to misunderstand them, it may be less important to continue to clarify knowledge gaps in this area. A move towards nutrition professional development programmes that focus on basic food groups and nutrients that demand less numeracy or literacy skills may prove more productive and meaningful.

ECE teachers may lack knowledge about appropriate everyday foods for pre-schoolers, as evidenced by foods high in saturated fat, sugar and/or salt being commonly served on special occasions and for fundraisers and some centre policies authorising these foods to be served on a regular basis [18]. However, this may be more of a reflection of the knowledge of ECE policy makers, which do not necessarily involve ECE teachers. It may be more likely that teachers are being misinformed and developing misconceptions about nutrition for pre-schoolers as a consequence. Nevertheless, New Zealand ECE centres that are celebrating special occasions with "occasional" foods weekly may be demonstrating a lack of awareness that the New Zealand Ministry of Health recommends serving "occasional" foods less than once per week. It is important to identify if ECE teachers and staff lack knowledge about the importance of limiting these types of foods, since regular consumption increases children's risk of obesity, developing chronic diseases [69-73], sugar-induced hyperactivity and dental caries [74]. In addition, always providing these types of foods at fun, celebratory or positive social events may encourage children to associate these foods with positive emotions, causing them to eat and choose foods based on emotional rewards rather than on satiety cues or nutrient needs [75,76]. This evidence may support the New Zealand Heart Foundation (2017) recently released *Healthy Celebrations* (2017) resource that provides recipes and practical ideas that help and encourage ECE teachers and parents to get creative with keeping healthy eating and physical activity an integral part of celebrations, for example, substituting traditional birthday cakes with a special birthday hat or using assembling fresh fruit into the shape of a cake. Teachers using this resource may be able to help provide children with the benefits of celebration (e.g. building relationships) without compromising children's healthy eating [77,78].

Despite the mixed evidence, a lack of knowledge towards child-feeding practices may be widespread in ECE teachers, especially towards involving children in meal preparation, food role modelling, cultivating satiety cues and managing picky eating [28,35]. This may be supported by negative beliefs amongst teachers, especially in view of Eagly AH, et al. (1993) [79], attitude construct that propose attitudes and beliefs partly reflect knowledge or vice versa. In other words, a belief that coaxing, bribing and/or restricting are suitable strategies to get children to eat new foods may demonstrate a lack of feeding practice knowledge amongst teachers [52,53]. In conflict, positive ECE teachers' beliefs such as not pressuring children to eat, role modelling food, involving children in meal preparation [52] and sitting with children at meal times [34] are important, which suggests that some ECE teachers are knowledgeable about recommended feeding practices. More research may clarify mixed results, yet it may be enough to know that knowledge gaps exist towards feeding practices and need to be addressed in future interventions. This is vital with considerable evidence supporting recommended feeding practices, for example, healthy food role modelling and eating together has been shown to improve dietary intake in children [58], whereas, using food (especially sweets and dessert) as a reward for good behaviour or to pressure/bribe children is counterproductive to establishing healthy food preferences and relationships [80,81]. Moreover, if these children establish negative eating habits during their highly impressionable pre-school years, they may be more likely to carry these behaviours into adulthood and so be at higher risk of on-going health problems [9].



In general, it seems ECE teachers believe that nutrition is important for health [34,38,44, and 50] and that they have a responsibility to promote health to children [38,82]. Yet, with several negative behaviours (e.g. serving unhealthy foods regularly), a lack of awareness of nutrition resources [37,39] and New Zealand ECE teachers expressing a lack of confidence in having conversations with families/whānau about healthy eating [56], it seems that ECE teachers may lack the knowledge, skills and abilities to translate good intentions into action. This seems possible in light of Ajzen I (1991) [83], *Theory of Planned Behaviour*, which shows attitudes and self-efficacy and skills are key determinants of behaviour. Although not all studies have found correlations between nutrition knowledge and health behaviours (a possible effect of not using validated measuring tools) [45,84], Azjen's theory supports studies in this review showing positive correlations between ECE teachers' nutrition knowledge and attitudes and practices [39,51]. Future interventions should not only provide teachers with nutrition knowledge for pre-schoolers, but also the skills and self-efficacy to put this knowledge into practice. Any needs assessment or evaluations must involve validated methodologies and nutrition knowledge measuring tools to ensure that true evidence is supporting and justifying interventions.

The ECE teachers likely lack nutrition knowledge as few teachers receive formal nutrition training [38,39, and 54]. In New Zealand and the UK teachers receive only a few hours (at most) of nutrition training during their 3- or 4-year teacher training qualifications, therefore, teachers may only gain nutrition knowledge if their childcare centre participates in a health promotion initiative [43]. Furthermore, ECE services tend to focus more on generic competencies (e.g. thinking) rather than domain-specific knowledge (e.g. nutrition) [85-89], which may reduce the likelihood of nutrition being taught. In addition, it seems that previous ECE teacher training is positively associated with nutrition knowledge [35,38], attitudes and practices [39], however, this is not always consistent [36,39]. More studies may clarify this relationship, nevertheless, reviewing current ECE teacher training may be beneficial for assessing methods for optimising ECE teachers' nutrition knowledge.

Overall, there is considerable variability across studies included in this review, which limits generalisability and makes it difficult to determine a specific level of nutrition knowledge for pre-schoolers in ECE teachers. Studies varied in terms of outcomes measured (e.g. nutrition knowledge versus attitudes), items included in questionnaires (e.g. food groups, RDIs, feeding practices, etc.) and validity of measuring tools. Some studies lacked detailed descriptions of questionnaire items [36,37,49, and 51], making it difficult to assess the fairness of tests. Yet, it is possible that most questionnaires were of similar difficulty, since there was only one instance (made transparent) when teachers could not have been expected to answer an item correctly without specialised training (e.g. "Can you draw the level of the human body and the brain that are made up of water (on the diagrams below?)" [44]). Many of the studies had a potential bias as they relied on self-reported data, used small samples sizes from a narrow geographical catchment and likely attracted participants that were interested in health, which may have skewed results. However, reviewing these studies and their limitations as a collection further highlights the need for more research in this area. Indeed, this review inspired our interest to conduct a study investigating ECE teachers' nutrition knowledge for pre-schoolers using a validated online questionnaire [90], which has since been published and confirmed both a need and desire for the delivery of nutrition training in childcare [91].

The main strength of this review is that this is, to the authors' knowledge, the first narrative review investigating ECE teachers' nutrition knowledge for pre-schoolers. Its broad inclusion criteria ensured that important articles were not missed. A main limitation of this review was that it lacked the comprehensiveness of systematic and meta-analysis methodologies, for example, no formal quality assessment of evidence was conducted, and searches were only conducted by one person. However, the quality of this review was enhanced by applying aspects of evidenced-based methodologies.

Conclusions

Early childhood education teachers appear to have lacked nutrition knowledge for pre-schoolers at least for the past three decades. It seems that although ECE teachers desire to support healthy eating in pre-schoolers, many may lack the knowledge, skills and abilities to do so. Although more up-to-date research is needed, ECE teachers should benefit from future interventions that aim to assist in translating nutrition recommendations for pre-schoolers (especially about food groups and feeding-practices) into action. This is important since teachers generally receive little nutrition training and may not be benefiting from current or previous intervention (since knowledge gaps seem to be persisting over time). Future research needs to directly measure ECE teachers' nutrition knowledge using validated tools in order to accurately identify knowledge gaps so that teachers can be offered relevant, practical nutrition education that gives them the confidence to support and create appropriate environments for pre-schoolers to make healthy choices. This recommendation is justified with growing acknowledgement that teachers and their nutrition knowledge influence child health.

Ethical Statements

Authors' Contributions

Rapson JP, Conlon CA & Ali A formulated the concept for the narrative review research questions and directed the literature review. Rapson JP carried out the literature review and compiled the data. Rapson JP wrote the manuscript. All authors reviewed and approved the final manuscript.

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Conflict of Interests

There are no conflicts of interest.

Ethical Approval

As this was a review of existing literature, no approval was needed.

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Availability of Data and Materials

No datasets were generated or analysed during the current study.

Consent for Publication

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