

and evidence-based decisions in the intervention's development and progress (Kok et al., 2016). The Intervention Mapping approach follows six iterative steps. In Step 1 (the needs assessment), the problem is analysed, and related behavioural and environmental causes are identified. Step 2 focuses on stating behavioural and environmental outcomes for problem reduction, which in combination with the determinants form the program objectives. In Step 3 theory- and evidence-based change methods are chosen to address program objectives. In Step 4 the methods from the previous step are translated into practical applications resulting in program production. In Step 5 the program implementation plan is constructed. Lastly, in Step 6 the program evaluation plan is set up by writing evaluation questions specified for process and effect evaluation (Bartholomew Eldredge et al., 2016).

RESEARCH QUESTIONS

Using the Intervention Mapping approach, the core processes for planning behaviour change interventions first point to the need to pose initial questions in order to ascertain causes of the health problem (Ruiter & Crutzen, 2020). To identify determinants of behaviour and environmental conditions and to help to develop interventions and anticipate implementation subsequent questions are formulated. Based on that the following three research questions were proposed: 1) Is self-efficacy is an important and changeable determinant related to the parental healthy feeding outcome behaviours?; 2) Were the right methods used to change self-efficacy in the original Module 3?; and 3) Does the newly developed model increase parental self-efficacy as compared to regular care and as compared to the current module? The three questions were answered in three separate consecutive studies.

STUDY 1: A RAPID SCOPING LITERATURE REVIEW

Perceived self-efficacy is a central component of Social Cognitive Theory (Kelder et al., 2015). Previous studies have shown that self-efficacy plays a major role in influencing health behaviours. Previous literature found self-efficacy as predictor for children's nutrition (Möhler et al., 2020). The objective of the present study was to examine whether parental self-efficacy is a relevant (i.e., important and changeable) determinant of parental feeding habits in parents with children aged 2–5 years. To identify what has been published so far on this topic, we conducted a rapid scoping review as part of Step 1 and Step 2 of the Intervention Mapping approach (note: in parallel, Bahorski et al., 2019 published a more elaborate

review on the same topic). The aim of the scoping review was to define the problem (i.e., the effect of self-efficacy on feeding behaviours) and the intervention outcomes (i.e., how to increase self-efficacy in parents to reduce unhealthy feeding behaviours). The scoping review was used to identify related behavioural and environmental determinants and find possible ways to reduce the problem. This information was used to adapt the intervention module.

METHODS

A literature search was carried out in April 2020. The databases PubMed and PsycInfo were used. The search strategy developed aimed to locate all studies addressing parental self-efficacy related to their feeding behaviours, thus included a combination of the following terms: words related to self-efficacy, variations of the word “parent”, and possible variations of the word “feed”. The full search strategy can be found in Appendix 2 on (<https://osf.io/2k8fe/>). No restrictions were made regarding the publication or document type, the year of publication, the publication status, the study design or the language used. Lastly, we checked the reference lists of all included studies, to check whether we missed potentially relevant records in our search. The following data were extracted from each paper and included in Appendix 2: Author, title, year, country, introduction and main content, self-efficacy definition, feeding behaviour, habit definition, intervention design, study design, age, participants (m/f), measurements, secondary outcomes, conclusions and limitations. The influence of self-efficacy on parental feeding habits from the included papers is summarized. No further comparisons were made between the papers.

We screened records in two phases, first title/abstract only, then full text. We only included studies that focused on (aspects of) habit change and publications examining the role of self-efficacy in studies investigating habitual feeding behaviours studies in parents of 2- to 5-year-olds. Articles were excluded if it was a duplicate (I), if it was not about children aged 2–5 years (II), if no parents were included (III), if no information was given on feeding behaviour (IV), self-efficacy (V), and habits (VI). Figure 1 demonstrates the search process represented in a flowchart with numbers of records excluded and their reason for exclusion.

RESULTS

A total of 603 records were found (PubMed: $n = 384$, PsycInfo: $n = 219$). Thirty papers were included after a first screening of the articles' title and abstract. Based on the full article screening, 21 more papers were excluded. Additionally, in a lateral search, two articles which met the inclusion criteria after full-text screening were added (Chen et al., 2018; Sun et al., 2017). No new articles were found relevant from the reference list of all included articles. All articles found were written in English. Finally,

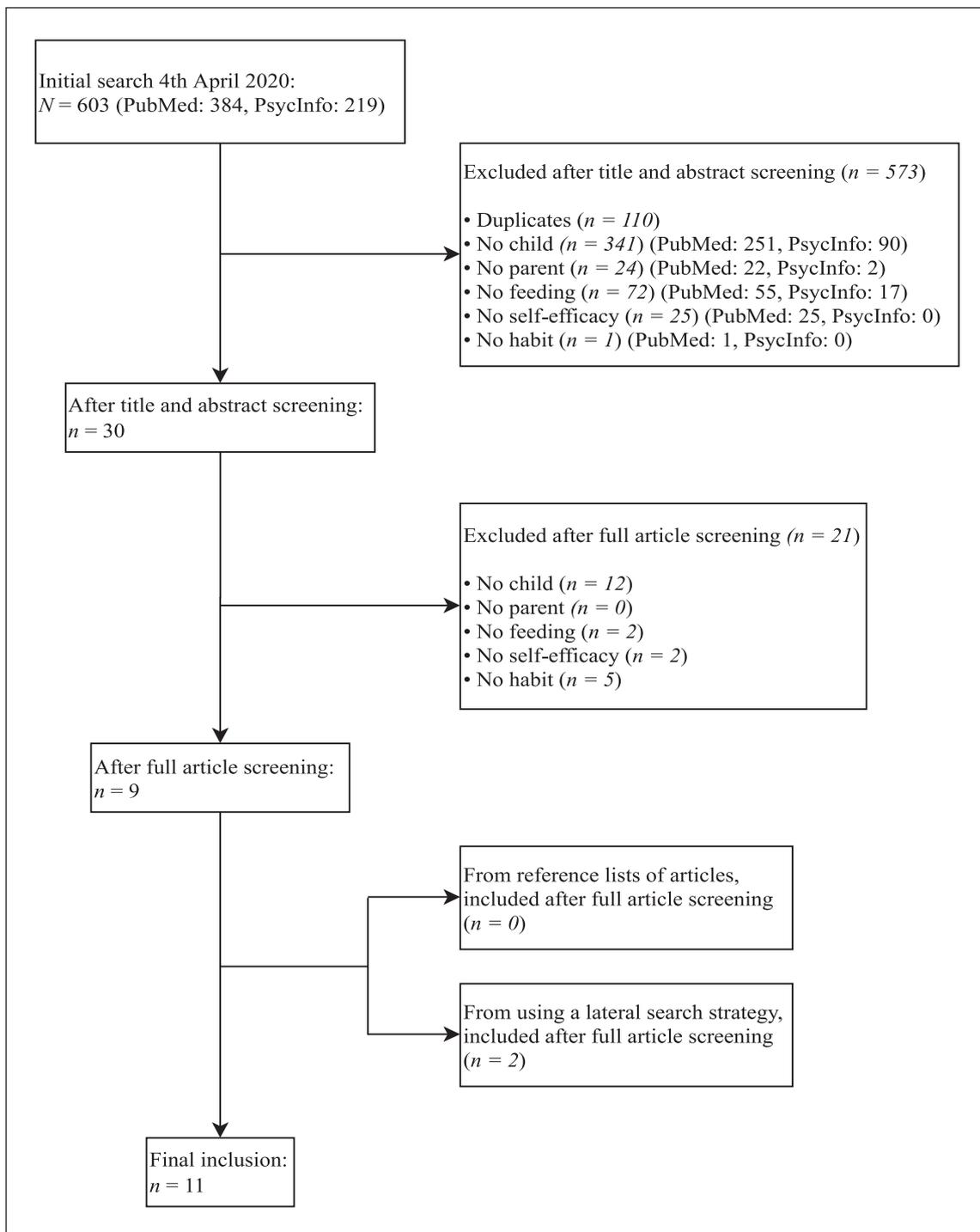


Figure 1 Flowchart Showing the Research Progress.

11 publications were included. An elaborate summary-table of results of the included articles can be found in Appendix 2 (<https://osf.io/2k8fe/>). All papers were published between 2010 and 2018. Five studies were conducted in the USA, four in the UK and two in China. In all of the studies, parents reported on their child's behalf. The number of participants ranged from 32 to 420 and in six studies the participants were exclusively mothers (Chen et al., 2018; Rohde et al., 2018; Sun et al., 2017) or mostly mothers (Baranowski et al., 2016; Diep et al., 2015; Morin et al., 2013). Nine of the studies entailed information about the development of future interventions and

suggested improvements for these interventions. Two of the eleven studies were interventions (Sun et al., 2017 used a RCT and Tabak et al., 2012 used a pre-post design without a control group). Seven studies were cross-sectional (surveys: Baranowski et al., 2016; Chen et al., 2018; Diep et al., 2015; Morin, 2013; Rohde, 2018; Shriver et al., 2010; Taverno-Ross, 2018). Lastly, one study used mixed methods (Foster, 2018). Duncanson et al., 2012, was a design document without additional data on the link between self-efficacy and parental feeding habits. All studies defined self-efficacy and provided information on the type of feeding behaviour investigated.

Outcomes of the Included Studies

Nine studies reported a significant effect of the influence of high parental self-efficacy with the habitual behaviour. These include allowing active child involvement in vegetable selection and positive communications about vegetables (Baranowski et al., 2016; Diep et al., 2015). Others looked at encouraging healthy eating behaviour (Chen et al., 2018; Foster et al., 2018; Sun et al., 2017), increasing fruit and vegetable consumption (Shriver et al., 2010), planning a menu for the upcoming week, preparation of healthy meals with only a few ingredients on hand, and preparation of meals in advance (Morin et al., 2013). Two further studies examined children's dietary intake and their physical activity (Rohde et al., 2018), and modelling behaviour through family recipe preparation (Taverno Ross et al., 2018).

Baranowski et al. (2016, p. 1980) found that "the barrier of the child not liking vegetables was positively related to parental self-efficacy, while the barrier of the respondent not liking vegetables was negatively related with parental self-efficacy". Parental practices had the most significant effect on feeding behaviour (Baranowski et al., 2016). Maternal self-efficacy showed a medium effect for promoting healthy eating (Sun et al., 2017). Moreover, Rohde et al. (2018) found that maternal self-efficacy for promoting healthy dietary behaviour was associated with higher fruit and vegetable intake in children. Tabak et al. (2012) reported a negative association of self-efficacy on vegetable intake of kids, but not when adjusted for age.

CONCLUSION STUDY 1

In this study, the effect of self-efficacy as a possible predictor of parental feeding habits was investigated. The literature showed that in addition to parenting practices, parental self-efficacy had a direct correlation with healthy eating behaviours in their children. In most of the studies, self-efficacy was found to be a relevant determinant in creating and maintaining healthy feeding habits. A limitation was that we included and compared findings of different types of study designs (i.e., RCT, pre-post, cross-sectional and mixed-method studies). This makes it difficult to compare, quantify, and generalize the effect of self-efficacy on feeding behaviours. While randomized controlled designs (RCTs) would be the best type of studies to infer this effect, as we found only one published (Sun), it was pragmatic to include other study designs.

STUDY 2: METHODS FOR CHANGING BEHAVIOUR IN MODULE 3

It was suggested that Module 3 was the least favourite module and hard to comprehend, based upon consultation with the target audience. Therefore, the

methods and techniques that were used to develop the original Module 3 were analysed and the translation from theoretical method to practical application was reconsidered (Bartholomew Eldredge et al., 2016; Ten Hoor et al., 2014). Bartholomew Eldredge et al. (2016) identified and defined behaviour change methods, including the parameters of effectiveness, which defines the condition(s) under which the theory-based behaviour change techniques can be effective. For this reason, the parameters of effectiveness were further examined to increase the likelihood of a positive change in the desired behaviour (Bartholomew Eldredge et al., 2016). Following the Intervention Mapping approach, the goal of study 2 was to focus and adapt the program's design. We chose theory and evidence-based change methods to address program objectives (Step 3 of IM), which were then translated into practical applications (Step 4 of IM). Lastly, we constructed an implementation plan (Step 5 of IM) (Bartholomew Eldredge, 2016).

METHODS

A study by Ten Hoor et al. (2014) served as a reference on how to apply behaviour change theories and increase the program's comprehensibility. The first step was to inspect the text elements of Module 3. The text from Module 3 of the intervention website was copied from the webpage. The text was divided into separate text sections. These text sections were assigned to the corresponding Intervention Mapping behaviour change methods. Associated with the behaviour change method used, the method's description by Bartholomew Eldredge et al. (2016) was added. Subsequently, the parameters of effectiveness were matched with the text content, evaluating whether the parameters of effectiveness were met or not.

Next, the understandability of the text of the original Module 3 was examined by using interviewing seven people who were diverse in their social-economic status. Semi-structured interviews were used. Participants were university staff and students, and people from the community recruited in Perth, the capital city of Western Australia. The total sample consisted of seven people, four women and three men with an age range between 20 and 54 years old. Three were parents (2 mothers and 1 father), three were students (2 post- and 1 undergraduate), and one was unemployed. Four were native Australians, and three were born outside Australia. Their task was to complete the original Module 3 step-by-step while reading it out loud. After each of the previously divided text sections (in terms of behaviour change methods), they stopped and gave their opinion and, if desired, made suggestions for improvement. For this purpose, a table was created containing the text passages as well as comments of the participants and their suggestions for improvement (see Appendix 4-10 on <https://osf.io/2k8fe/>).

The third step was to systematically describe how the text could be improved, incorporating the parameters of effectiveness (Bartholomew Eldredge et al., 2016) and the suggestions by the participants.

RESULTS

Each text paragraph of the original Module 3 was assigned to one of four categories of behaviour change methods. These methods were labelled as “Methods to Change Skills, Capability, and Self-Efficacy and to Overcome Barriers”, “Methods to Change Awareness and Risk Perception”, “Methods to Change Habitual, Automatic, and Impulsive Behaviours” and “Methods to Change Attitudes, Beliefs and Outcome Expectations”. The first method addresses self-efficacy as a behavioural determinant, which was the main component of Module 3. The other two methods address habit change and increasing awareness of healthy feeding behaviour, which were secondary components of Module 3.

During the interviews, five out of seven participants thought that the technical terms were presented reasonably. They also confirmed that they liked when technical terms were used because this contributed to the credibility of the methods and made the program more interesting. On the other hand, two participants stated that they were confused by technical terms (such as “if-then statements”). All participants remarked that there was too much text. They commented that the program lacked clear paragraphs and structure, making it challenging to identify differences between the four topics in Module 3. Furthermore, all participants mentioned that the given examples were redundant and sometimes inappropriate. To make the module more appealing, one participant suggested changing the pictures. Additionally, one participant proposed including a role model in the program for parents to identify with. For all feedback and suggestions, see Appendix 4–10 on <https://osf.io/2k8fe/>.

Based on the systematic categorization of methods and the interviews, the module was revised (Appendix 11; <https://osf.io/2k8fe/>). All methods, parameters, and systematic changes can be found in Table 1 (Appendix 3).

CONCLUSION STUDY 2

The inspection of the text sections of the original Module 3 showed that self-efficacy was sufficiently targeted. In all text sections, behaviour change methods were identified, but the parameters of effectiveness for these methods were not always fulfilled adequately. Furthermore, the interviews with people from our target audience indicated that the text in Module 3 was lengthy, unclear, and sometimes inappropriate. This may explain why previously Module 3 was chosen as the least favourite module (Mullan et al., 2020). Hence, to improve the efficiency and the acceptability of the methods used, the text sections were adapted in a systematic and theoretical way.

STUDY 3: TESTING EFFICACY OF THE NEW MODULE – A PILOT STUDY

In our literature search (Study 1), self-efficacy was identified as a relevant determinant in parental feeding practices. Study 2 used the theory-based application of behaviour change methods with self-efficacy and habits as underlying determinants, and a new Module 3 was designed. Thereupon, Study 3 pilot-tested whether parental self-efficacy was increased after having received the new Module 3 compared to the original Module 3 and a control-condition.

METHODS

Participants and Recruitment

Participants included primary caregivers of children aged 2–5 years. Two methods of recruitment were used. Participants were recruited by emailing directors of 22 childcare centres in Perth, WA. From the 22 childcare centres answers were received from six of them (average response rate: 27%). Secondly, recruitment took place on Amazon.com’s Mechanical Turk (MTurk). MTurk is an online marketplace where workers (mostly Americans) are paid for completing Human Intelligence Tasks (HITS; Boas, Christenson, & Glick, 2018). The study was approved by Curtin University’s Human Research Ethics Committee (HRE2019-0094). Every parent having one or more children between 2–5 was eligible to participate in the study.

Intervention Design

A randomized-control trial was designed to test the efficacy of the newly developed Module 3 over three weeks. The intervention consisted of Module 1, an introductory module to the CHEETAH program delivered during the first week of the intervention and Module 3, the CHEETAH module aiming to improve parental self-efficacy, delivered after Module 1 in week 2 and 3 of the intervention. Participants were randomly but evenly assigned to three different conditions: they either received the original version of Module 3, the new version of Module 3 or were assigned to a control-condition. In the control-condition, they were directed to the webpage of either the Australian (Australian Government) or the American guidelines (American Heart Association) for the recommended serving sizes for fruits and vegetables for children, depending on where the parents were recruited.

Protocol of Study

Data were collected via Qualtrics at baseline (T0: week 0), directly after the intervention (T1: week 3), and after 1 week follow up (T2: week 4). Prior to the beginning of the study, informed consent was provided by participants. The inclusion criteria for participation in the study was (1) being a parent of a 2–5-year-old, (2) understanding English, and

(3) having access to the internet. Moreover, parents were informed that their participation was completely voluntary and they could withdraw from the project at any time. Before parents started the survey, they were instructed that if they had multiple children in the target age group, they should only keep one of their children in mind when answering the questions in the study. Furthermore, a reader-check was added to the survey to ensure that parents read all instructions carefully.

At T0, parents' eligibility was checked, and demographic and self-efficacy measures were assessed (see Measures). Participants were then randomised into the three groups and received the intervention over three weeks. At T2 and T3, parental self-efficacy was measured again. The questionnaires took approximately 30 minutes to complete and the intervention could be completed in 10 minutes, however, participants were instructed to take as much time as they needed or wished to use. Participants were reimbursed with a \$20 gift voucher after completing the whole study.

Measures

Demographic Measures. Parents indicated their child's age and age group (1: 2–3 years, 2: 4–5 years), as different fruit and vegetable recommendations applied for each age group. In addition, they indicated their gender, the child's gender and the number of children they have.

Time Spent on Intervention. The time spent to complete the intervention modules and the questionnaire was measured in seconds at T0, T1, and T2.

Parental beliefs (including Self efficacy). Parental beliefs (including self-efficacy) was measured regarding fruit and vegetable feeding behaviour. Parents were asked to report whether they provided their child with the recommended serving size for fruit and vegetables (American Heart Association; Australian Government) on an average day over the last two weeks (Strachan & Brawley, 2009).

The questionnaire consisted of 34 questions covering direct measures of self-efficacy, attitude, subjective

norm, normative beliefs, intention, past behaviour, motivation to comply, outcome evaluations, behavioural beliefs, control beliefs, and power of control factors (Ajzen, 2017). All items were rated using an eleven-point Likert scale where 0 = strongly disagree/extremely unpleasant/not at all likely/extremely bad/never and 10 = strongly agree/extremely pleasant/extremely likely/extremely good/always. As the number of participants in this pilot-study was low, it was decided to not further focus on determinants other than self-efficacy in this paper. For the full questionnaire and additional analyses, please see Appendix 12; <https://osf.io/2k8fe/>.

GLMM Data Analysis

Data were analysed using a Generalised Linear Mixed Model (GLMM). GLMM was used in preference to the traditional ANOVA approach because it is better at accommodating violations concerning normality, linearity, and homogeneity of variance (Stroup, 2012). Nevertheless, it must be noted that the assumptions may have been violated. The data were transformed from a repeated-measures ANOVA to the long format of the GLMM analysis. Participants' ID was included as a random factor. Moreover, 'gender', 'condition', 'child age', 'number of children', 'time*condition' were included as continuous fixed effects, and self-efficacy as a fixed within-groups factor (Appendix 13).

RESULTS

Participant Demographics

In total, 34 participants registered to take part in the study, and 27 parents ($n = 15$ mothers) completed the whole program. Those parents were then assigned to one of the treatment conditions (original module-condition: $n = 10$, new module-condition: $n = 9$, control condition: $n = 8$). Seven participants had one child, 13 parents had two children, six participants had three children, and one parent had five children. Fifteen children were in the age group 2–3 years and 12 children were aged 4–5 years. Children's mean age was 2.11 ($SD = 0.91$) years. Table 2 shows the distribution of parental gender, children's mean age and children's age

VARIABLE	T0 (WEEK 0)				T1 (WEEK 3)				T2 (WEEK 4)			
	TOTAL	ORIGINAL MODULE	NEW MODULE	CONT-ROL	TOTAL	OLD-MODULE	NEW-MODULE	CONT-ROL	TOTAL	OLD-MODULE	NEW-MODULE	CONT-ROL
N	27	10	9	8	27	10	9	8	27	10	9	8
Gender (M:F)	(12:15)	(6:4)	(3:6)	(3:5)	(12:15)	(6:4)	(3:6)	(3:5)	(12:15)	(6:4)	(3:6)	(3:5)
Child-age group (2–3 years: 4–5 years)	(15:12)	(6:4)	(7:2)	(2:6)	(15:12)	(6:4)	(7:2)	(2:6)	(15:12)	(6:4)	(7:2)	(2:6)
Mean age children $M(SD)$	2.11 (.92)	2.40 (1.27)	1.89 (.60)	2.00 (.71)	2.11 (0.92)	2.40 (1.27)	1.89 (0.60)	2.00 (0.71)	2.11 (0.92)	2.40 (1.27)	1.89 (0.60)	2.00 (0.71)
Self-efficacy	6.85 (1.73)	6.80 (1.03)	7.61 (.89)	5.56 (2.54)	7.05 (1.16)	7.30 (1.16)	7.22 (1.23)	6.65 (1.11)	7.21 (1.38)	7.65 (0.97)	7.67 (0.83)	6.28 (1.81)

Table 2 Means and Standard Deviations of Participants' Determinants at Time 0 (week 0), Time 1 (week 3) and Time 2 (week 4).

Note: Gender (F) = female, Gender (M) = male, M = Mean, SD = Standard Deviation.

group per condition. The majority of participants lived in the US ($n = 25$) and two participants lived in Western Australia.

Time Spent on the Intervention

At T0, the average time spent on Module 1 and the baseline questionnaire was 606.97s (10.12 minutes). At T2, participants spent 481.70s (8.03 minutes) in the original module-condition, 427.33s (7.11 minutes) in the new module-condition and 325.50s (5.42 minutes) in the control condition. Due to the adaptations, which were made to the new module, as expected, the average duration time was longer in the original-module-condition compared to the adapted-module-condition and the control-condition. The average duration was 561.68 (9.35 minutes) at T2.

Self-Efficacy

A significant main effect of condition, $F(2, 71) = 3.88, p = .025$, partial $\eta^2 = .098$ and a significant interaction of time and condition were observed, $F(6, 71) = 2.65, p = .022$, partial $\eta^2 = .180$, indicating different self-efficacy patterns

over time between the three conditions. Figure 2 suggest that participants' perceived self-efficacy increased over the three time points in the original-module-condition, however in the new-module-condition self-efficacy seems to decrease from T0 to T1 and increase from T1 to T2. Lastly, in the control-module-condition, self-efficacy seems to increase from T0 to T1 and decrease from T1 to T2.

Pairwise comparisons, however, showed that there were no differences in trajectories over time between the three conditions, all $t < .393, p > .766$. We found that the two-way interaction was significant because there were different levels of self-efficacy at T0 between the new-module-condition and the control-module-condition, $t(15) = 2.28, p = .030$, but not between the new-module-condition and the original-module-condition, $t(17) = 1.18, p = .085$. At T1, no significant effects were reported between any of the conditions, all $t < .998, p > .334$. At T2, we found that the people in the control-module condition had significantly lower self-efficacy compared to the other two modules, both $t > 2.58, p < .010$.

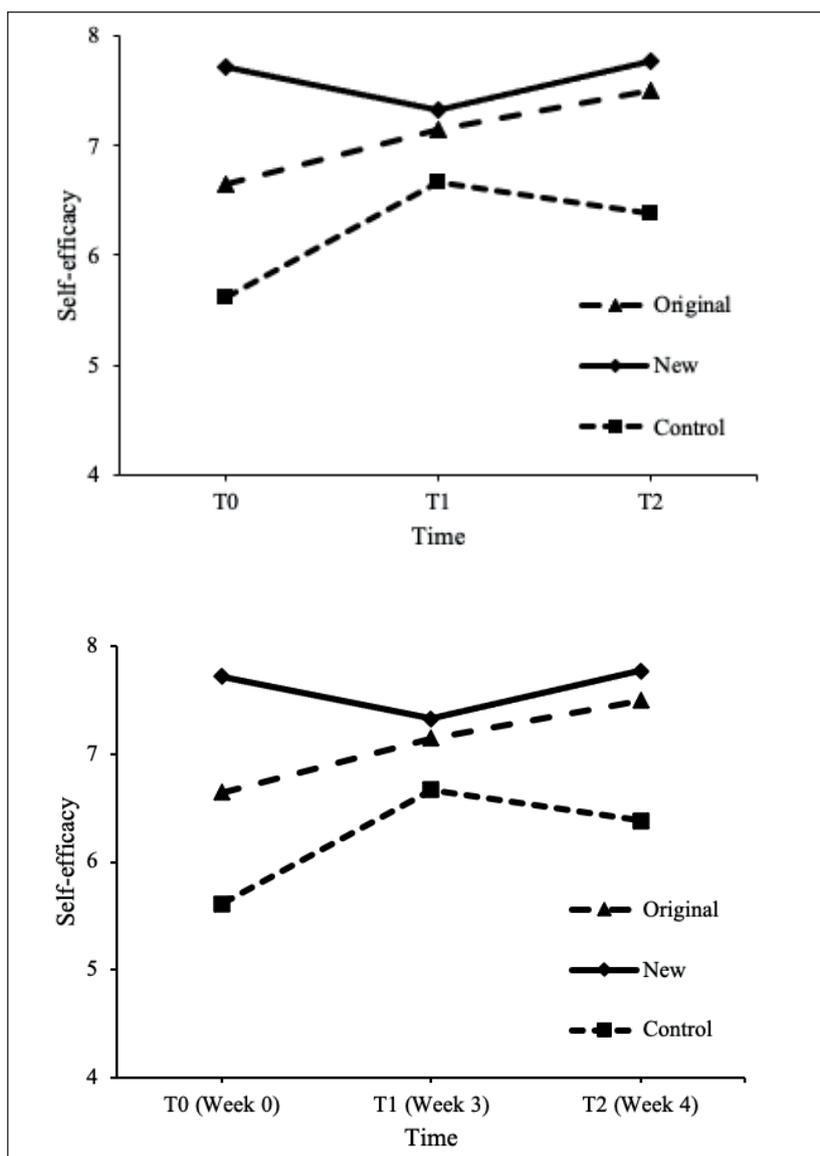


Figure 2 Changes in Self-Efficacy as a Function of Time and Condition.

CONCLUSION STUDY 3

Parental self-efficacy was not significantly enhanced at post-treatment and follow-up compared to the baseline measurement in the new-module-condition. This was likely the case because of the higher self-efficacy levels at baseline suggesting a ceiling effect. People in the original-module-condition showed an increase of self-efficacy over time; a positive linear increase in the self-efficacy score was observed. Given there was no difference between the new- and original-module post-treatment and at follow-up, and self-efficacy levels in both these conditions were significantly higher than in control at follow-up, we can conclude that both self-efficacy modules increased self-efficacy compared to the control-module-condition one week after engaging with the modules. A limitation was that we did not check whether feeding behaviour or eating was found as moderator. Another limitation is that with only 34 participants in total (and only 27 completing the program), the response rate was very low, and a strong selection bias has likely occurred.

GENERAL DISCUSSION

Parent-based interventions promoting healthy eating for preschool children have proven to be successful in effectively targeting healthy eating behaviours to reduce overweight and obesity (Nader et al., 2012; Hammersley, 2017). The healthy parental feeding program was developed as an online intervention to improve parents' feeding behaviours. This study proposed an approach to further improve the program's effectiveness, starting with a literature review, followed by theory- and evidence-based application of behaviour change methods, concluding with data collection to test the changes that were made in the previous steps. We found in our literature review that different researchers used different questionnaires to measure self-efficacy and feeding behaviour. Furthermore, some studies used a quantitative data collection approach except for three studies using qualitative interviews, which made it problematic to compare the results. Hence, we recommend that future studies use standardized assessments using validated measures of self-efficacy (e.g., following suggestions by Fishbein and Ajzen, 2010) and feeding behaviours (e.g., following suggestions by Musher-Eizenman et al., 2007). Moreover, we found that the new module was not more effective in increasing self-efficacy compared to the original module. A reason for why there was no difference between the original- and new-module may be due to the shortening of the original Module 3 in Study 2, not all of the intended behaviour change techniques and the corresponding methods of change could be implemented. However, both interventions (original and

new) seem to improve self-efficacy, while self-efficacy in the no intervention control group did not.

LIMITATIONS AND FUTURE DIRECTIONS

The main limitation to this study was the high baseline self-efficacy level in parents in the original module condition. As a result, changes over time in this condition were not possible (i.e., a ceiling effect). This made it difficult to compare the effectiveness of the new model in increasing self-efficacy compared to the old model. In addition, this makes it difficult to generalize the sample to parents who may have lower self-efficacy. The results suggest that it is important that we target parent with lower self-efficacy levels, as they are most likely to benefit from the program compared to parents' high in self-efficacy. More research is needed to determine how we can reach parents who are low in self-efficacy. Another limitation was that we did not include a human role model as was suggested by participants in Study 2. We had to make concessions as other feedback related to the length of the Module suggested that less was more, thus including a description of a role model would make the module very long possible decreasing engagement. Creating a video was not possible at the time of this study due to practical limitations of COVID-19 lockdown measures. Additionally, because participants took less time to complete the study than previously expected (i.e., 30 vs 9 minutes), future research should consider investigating to what extent duration influences the effectiveness of the module. Furthermore, it should be acknowledged that this study focused only on one module of the intervention in isolation. It must be conceded that the results of a single module of the program tested here could differ from when we would test the effect of this module as a part of the whole intervention. Intervention modules likely interact and engaging with multiple modules may enhance the effects found of this module tested in isolation. Besides improving the actual module, this study is a showcase on how other modules of this or other programs could be improved by using the Intervention Mapping approach. Future research could test the effects on habit change of the new Module 3 as part of the whole program.

Another limitation of study 3 was the online data collection method. Because of the COVID-19 lockdown measures in place at time of data collection, there was no opportunity to collect data other than online. Nevertheless, we are aware that previous research found that data collection on MTurk could be influenced by low data quality leading to data invalidity (Chmielewski & Kucker, 2019). To reduce the effects of this limitation, we implemented an instructional manipulation check, nevertheless, the data could be biased due to an unrepresentative sample (Chmielewski & Kucker, 2019). Lastly, a limitation was the small sample size affecting the reliability and generalizability of the study. The study

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