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Identification of Behaviour Change Techniques applied in interventions to improve Cooking Skills and Food Skills among adults.

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What is already known on this subject? Cooking and food skills interventions are growing in popularity. There is a pressing need to better understand the effective components within these behaviour change interventions. Identifying and analysing behaviour change techniques (BCTs) within interventions are now possible using a published, reliable, taxonomy of techniques.

What this study adds? The most common BCTs used within cooking and food skills interventions among adults were: (1) providing information; (2) providing instruction; (3) demonstrating behaviours and; (4) providing opportunities to practice. Interventions containing all four elements within one intervention achieved behaviour change in cooking and diet beyond three months. Incorporating these findings in future cooking and food skills interventions and robustly testing their effectiveness will advance the understanding of behaviour change and improve public health outcomes.

Abbreviations

BCT behaviour change technique

CS cooking skills

FS food skills

ABSTRACT

Background: Cooking and food skills interventions have grown in popularity however there is a lack of transparency as to how these interventions were designed, highlighting a need to identify and understand the mechanisms of behaviour change so that effective components may be introduced in future work. This study critiques cooking and food skills interventions in relation to their design, behaviour change techniques (BCTs), theoretical underpinnings, and outcomes.

Methods: A 40-item CALO-RE taxonomy was used to examine the components of 59 cooking and food skills interventions identified by two systematic reviews. Studies were coded by three independent coders.

Results: The three most frequently occurring BCTs identified were: #1 *Provide information on consequences of behaviour in general*; #21 *Provide instruction on how to perform the behaviour* and #26 *Prompt Practice*. Fifty-six interventions reported positive short-term outcomes. Only fourteen interventions reported long-term outcomes containing BCTs relating to information provision.

Conclusion: This study reviewed cooking and food skills interventions highlighting the most commonly used BCTs, and those associated with long-term positive outcomes for cooking skills

and diet. This study indicates the potential for using the BCT CALO-RE taxonomy to inform the design, planning, delivery and evaluation of future interventions.

Keywords

cooking skills, interventions, diet, behaviour change techniques.

INTRODUCTION

Cooking and food skills interventions have resulted in improved diet and health outcomes^[1, 2, 3, 4, 5, 6]. However, there is a lack of clarity and understanding regarding the ‘active components’ or discrete behaviour change techniques used within these interventions (*referred to as BCTs from this point onwards*). Further, there is a lack of understanding on how the design of cooking and food skills interventions impact their effectiveness outcomes, as well as the role played by theoretical frameworks in promoting behaviour change in this domain^[3]. This study defines cooking skills as ‘a set of mechanical or physical skills used in meal preparation’^[1] however as domestic cooking involves broader, more complex processes, food skills should also include: perceptual meal planning, food acquisition, organisational and creative skills as well as those relating to nutrition and food hygiene^[1].

There is considerable evidence linking poor dietary intake with multiple chronic illnesses worldwide such as diabetes, cancer and cardiovascular disease^[1,4,5]. The ability to cook and prepare meals from basic ingredients at home is posited and demonstrated as an integral component in the consumption of a healthy diet and diet quality^[1]. Cooking and meal preparation have become increasingly important in Western countries where food consumption patterns have changed^[6] with family-centred mealtimes declining^[7], and lifestyles and workloads increasing, resulting in a decrease in domestic cooking skills, time spent in meal preparation and an increase in fast food consumption^[8]. Recent cross-sectional studies report a link between greater consumption of convenience and fast food and poorer health outcomes^[9]. In order to address these issues, as well as the escalating cost of health-related illnesses^[10] cooking and food skills

interventions targeting dietary outcomes have grown in popularity within the public health sector^[11].

Michie (2011) published a refined 40-item CALO-RE taxonomy^[2] of BCT used to characterise the active components of inventions (e.g. barrier identification, goal setting and feedback on performance) to understand ‘what works’ in a given circumstance, or within a particular population group, maximising future intervention efficacy^[12]. In addition, a robust approach to ‘*standardising*’ behavioural interventions with regard to design, content, setting and population group has been advocated by researchers to identify factors which lead to successful behaviour change^[12].

In light of the above, this paper used Michie’s CALO-RE taxonomy^[2] to review existing cooking and food skills interventions to identify the BCTs employed. In addition, the study examined current cooking and food skills interventions in terms of their sample, theoretical underpinnings, design, and long and short-term outcomes.

METHOD

Search Strategy

Cooking and food skills interventions were extracted from two worldwide systematic reviews, Reicks et al (2014)^[13] and Reicks et al. (2016, *under review*)^[14]. Both reviews were selected due to their recency, relevance and robustness in their design. Both systematic reviews^[13, 14] provided an international perspective on cooking skills and food skills interventions with adults. The first review^[13] identified relevant research published between January 1980 and December 2011. A total of 319 journal articles were identified (excluding duplicates) and screened which resulted in twenty-five studies meeting the inclusion criteria (discussed later). The second review

^[14] identified relevant research between January 2012 to March 2016. A total of 2365 journal articles were identified (excluding duplicates) and screened which resulted in thirty-four studies meeting the inclusion criteria. Both review studies used the same keyword searches across three electronic databases (OVID MEDLINE, Agricola, and Web of Science) (*please refer to original papers for more details*).

Screening

Full text papers and reports which could not be accessed via online databases and web searches were provided by the author of the review papers and included in the present sample. All studies were screened by Reicks et al. ^[13, 14] against the six-point inclusion criteria detailed below. From both reviews, a total of fifty-nine papers on community cooking and food skills interventions with adults were identified.

Eligibility

The eligibility of inclusion in the present study was as follows:

1. Population: focus on adults (18 years +).
2. Intervention: any intervention that targeted the development of cooking skills/food skills with a hands on or demonstration/observation cooking component.
3. Outcomes: reported behavioural outcomes relevant to the intervention target i.e., health, dietary and psychological outcomes.
4. Date: published after January 1980.
5. Language: published in the English language.

6. Duplication: In cases with multiple publications on the same study (*in this case the paper with the most comprehensive explanation of the methodology and results was used, for example, Condrasky ‘Cook with a Chef’ Intervention*).

Data extraction

All studies were analysed and the following information extracted: country, target population, sample size, intervention purpose, design, theoretical underpinnings informing the design of the intervention, primary and/or secondary outcomes (i.e., pre and/or post measures), and any reported long-term outcomes (i.e., post 3 months). Interventions were then coded using Michie et al.’s (2011) CALO-RE taxonomy^[2] BCTs were mapped where identifiable according to cooking skills (i.e., the mechanical process of cooking, chopping etc.) and food skills (i.e. perceptual planning, acquisition, organisational and creative skills as well as those relating to nutritional knowledge and food hygiene).

On examination of specific BCTs within the CALO-RE taxonomy^[2] certain definitions required further clarification and standardisation to relate the taxonomy specifically to cooking and food skills interventions. To minimise any discrepancies surrounding inter-coder agreement in relation to the interpretation of each BCT, a codebook of definitions was discussed and agreed upon with two researchers involved in the coding process (DS and FL). In addition, the coders contacted the taxonomy authors for clarity over any discrepancies. For example, BCT #26 *Prompt Practice* explicitly states ‘prompt the person to rehearse and repeat the behaviour or preparatory behaviours numerous times’. However, for the purposes of this study it was agreed (with the taxonomy authors) to extend the definition of this BCT to include the carrying out of a practical

task relating to cooking skills or food skills even once ^[2]. A third coder (LH) reviewed all interventions and codes to ensure consistency.

Data Analysis

Each research paper was read several times to gain a full understanding of the nature of the intervention. A deductive coding approach was applied using the taxonomy^[2] to identify the total number of BCTs within each intervention. The methodology and results of each paper were scrutinised and the CALO-RE framework was applied. Each BCT was then inspected for overlap and to ensure the correct classification was made. The papers were independently coded by the first researcher (DS) who previously had undergone BCT coding training. To ensure inter-coder reliability a sample of approximately 50% of interventions were independently coded by (FL), then 10% of the full sample coded by a third researcher (LH). BCT outcomes were subsequently cross-mapped between coders and any discrepancies were discussed and reconciled. Results were collated and summarised so intervention outcomes could be compared with specific BCTs or combinations of BCTs identified (see Table 1).

RESULTS

Overall, the results displayed some commonalities among the interventions relating to intervention design, BCTs used and theoretical underpinnings reported.

Intervention Design

A total of fifty-nine cooking and food skills interventions were included within the present study and are summarised in Table 1. Overall, twenty-four interventions included mainly practical cooking sessions to develop cooking skills and thirty-five interventions focused on wider food skills issues, to include promoting nutritional knowledge, accessing healthy ingredients and

budgeting as a means to change dietary behaviour with some cooking skills teaching. Of the fifty-nine interventions included in this study, thirty-one were conducted in the US^[15, 16, 19, 20, 21, 22, 23, 27, 28, 29, 30, 33, 36, 37, 40, 41, 42, 44, 45, 47, 50, 51, 53, 54, 55, 56, 61, 62, 65, 68, 73], six in the UK^[18, 31, 32, 35, 52, 64], five in Australia^[17, 25, 2, 57, 58], four in Canada^[39, 42, 48, 69], three in Scandinavia^[38, 66, 70], two in Japan^[59, 60], two in Italy^[48] and one in China^[46], India^[43], Indonesia^[49], South America^[34], Netherlands^[67] and the Republic of Ireland^[63].

Of the fifty-nine intervention designs, twelve were randomised controlled trials (RC)^[36, 37, 38, 39, 45, 54, 60, 63, 65, 66, 67, 69], twelve were non-randomised controlled trials (NRC)^[31, 32, 33, 34, 35, 40, 41, 42, 43, 44, 46, 59], and the remaining thirty-five studies were pre/ post or post evaluations only. Sample sizes ranged from twenty-one participants to 7,422 participants with a mean of 359 participants. The target population for each intervention varied and was coded into five main groups: sixteen interventions targeted low-income and vulnerable groups (e.g., the elderly)^[19, 24, 25, 26, 31, 32, 33, 34, 41, 46, 50, 52, 55, 58, 60, 61, 68]; twenty interventions targeted groups with health needs (e.g., recovering cancer patients or ‘cancer survivors’)^[21, 27, 28, 35, 38, 39, 42, 44, 45, 48, 54, 59, 63, 64, 66, 67, 69, 70, 71, 72]; fourteen interventions targeted the general adult population (including students)^[15, 16, 23, 28, 36, 37, 40, 43, 51, 53, 57, 65, 73]; six interventions targeted specific cultural groups (e.g., Aboriginal adults)^[17, 18, 20, 22, 47, 56] and, three interventions targeted families^[30, 49, 62]. Of the fifty-nine interventions, forty interventions recruited a mixed gender sample fourteen interventions recruited a female only sample, and five interventions recruited a male only sample (see Table 1).

With regard to intervention duration, six included only one session^[15, 16, 34, 47, 62, 67], thirteen interventions ran between two to four sessions^[25, 26, 27, 36, 37, 42, 44, 46, 51, 56, 66, 68, 70]; seventeen

interventions included five to seven sessions^[19, 20, 22, 29, 30, 31, 33, 35, 40, 49, 53, 55, 59, 61, 63, 72]; ten interventions included between eight to ten sessions^[23, 24, 28, 32, 43, 52, 54, 57, 59, 73]; eleven interventions included eleven or more sessions^[17, 18, 21, 38, 39, 41, 45, 48, 60, 64, 65] and; two interventions did not disclose this information^[58, 71].

BCTs Identified across Interventions

BCTs were identifiable in all 59 studies; employing between one and eleven of the 40 BCTs, though none explicitly reported intervention techniques as ‘BCTs’. Thirteen interventions incorporated less than four BCTs^[15, 16, 29, 40, 41, 42, 55, 57, 58, 60, 66, 71, 72], twenty-two interventions included four to six BCTs^[19, 20, 25, 29, 30, 31, 35, 37, 44, 46, 48, 50, 52, 56, 59, 62, 63, 67, 69, 70, 73]; twenty- one interventions between seven and ten BCTs^[21, 22, 24, 26, 27, 32, 33, 34, 36, 41, 43, 45, 47, 49, 51, 53, 54, 64, 65, 66, 68], and three interventions incorporated eleven BCTs^[23, 38, 39]. The following BCTs were not used because they were not applicable to the cooking skills interventions chosen for this analysis; BCTs# 3, 14, 25, and 31-40. As illustrated in Figure 1, the top six BCTs most frequently used across the fifty-nine interventions were (in descending order): BCT#1 *Provide information on consequences of behaviour in general*.

Many interventions applied general information such as nutritional education to meet the needs of the individual. For example, the “*Eating Right*” intervention promotes the instructor’s role as facilitating experiences to meet the needs of the learner and their prior experiences^[22]. BCT#21 *Provide instruction on how to perform the behaviour* was the second highest ranking BCT identified. Many of the practical cooking interventions used recipes and methods which could realistically be replicated in the home setting, for example in offering advice on inexpensive ingredients which may be sourced easily within participants own communities^[21, 23]. Thirdly,

BCT#26 *Prompt practice* e.g. prompting individuals and groups to take part in practical cooking sessions. Fourthly, BCT#22 *Model or demonstrate the behaviour*, where cooking group facilitators may demonstrate a cooking method to promote learning. BCTs #20 and #2 jointly ranked in fifth place. BCT#20 *Provide information on where and when to perform the behaviour*. In addition to offering information on how to carry out food skills, these interventions suggested where to carry out the behaviour. This was illustrated in the “Food Cent\$” sessions advise participants how to carry out food skills and where to access inexpensive ingredients^[24]. BCT#2 *Provide information on consequences of behaviour to the individual*; for example, during the “Cookwell Programme”^[31], participants were offered nutritional information, to include the consequences of excess saturated fat and sugar on their personal diet and lifestyle. Lastly BCT #8 *Identify barriers/problem solving* where participants were encouraged to consider barriers to behavioural change then problem solve to overcome issues preventing behavioural change (see Figure 1). The “Friends with Food Programme”^[32] was a nutritional education programme which encouraged a sample of low income women to plan and prepare familiar family meals. Following sessions on nutrition and healthy eating, problem solving discussion was facilitated on how what prevents individuals cooking healthy meals at home and individuals considered ways in which these barriers such as financial restrictions, could be overcome.

BCTs Identified within Interventions and Related Outcomes

Each intervention contained one to eleven BCTs (mean 7.4 BCTs; mode 5 BCTs) aimed to promote behaviour change (see Table 2). Across the interventions, BCTs #1 and #2 related to information provision commonly appeared together (twenty-three out of fifty-nine interventions).

BCT#1 related to providing general information on the consequences of the behaviour, whereas BCT#2 extended this by providing information on the consequences of the behaviour specifically related to the individual, i.e., tailored or personally relevant information. It was also common for BCT#20 and BCT#21 to be used together with an intervention (twenty-two out of fifty-nine studies) where BCT#20 was related to information on where and when to perform a behaviour, BCT#21 was based on providing instruction on how to perform a behaviour. In thirty of the studies, BCT#26 *Prompt practice* accompanied BCT#21. In nine of the interventions BCT#22 *Model or demonstrate the behaviour* also accompanied BCT#20 and BCT#21.

Of the fifty-nine interventions, fifty-five reported positive outcomes at the close of the intervention or in the short-term (i.e., within three months) [All interventions except for^[17, 63, 70, 72]. The studies measured behaviour change in terms of health outcomes, dietary outcomes and psychological outcomes. Of the studies, eighteen identified short term behavioural change in relation to health (e.g. reduced cholesterol)^[28, 35, 41, 42, 43, 45, 46, 48, 49, 50, 51, 63, 64, 66, 67, 69, 71, 73], twenty six in relation to dietary outcomes (e.g. improved nutritional intake)^[17, 20, 21, 23, 25, 28, 32, 33, 35, 42, 43, 44, 45, 49, 52, 53, 54, 55, 56, 57, 58, 61, 64, 67, 68, 73] and forty in relation to psychological change (e.g. improved nutritional knowledge)^[15, 16, 17, 18, 19, 20, 22, 24, 25, 26, 27, 29, 30, 31, 32, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 49, 51, 52, 53, 57, 58, 59, 60, 61, 62, 68, 69, 70]. Long-term positive outcomes (greater than three months) were reported in fourteen of the fifty-nine interventions^[18, 19, 21, 23, 24, 50, 51, 52, 54, 57, 58, 64, 65, 66]. Fifty-six interventions contained BCT#1 (information on the consequences of the behaviour in general); and, BCT#26 (prompt practice). Table 2 illustrates the BCTs identified within each intervention and highlights short- and long term outcomes.

For the fourteen interventions reporting long-term successful outcomes (based on health, dietary and health outcomes), half ($n = 7$) were conducted in the United States, three in the United Kingdom, two in Australia, one in Indonesia and one in Canada. Samples were of mixed gender for the majority of studies though males exclusively participated in five studies. The target population for each of these interventions varied, with no discernible pattern, e.g., some were drawn from the general population, some from specific cultural groups, some low-income and vulnerable groups and some with specific health needs. The fourteen studies stating long-term positive outcomes contained between four and twenty-eight cooking sessions with the most common BCT's reported being; BCT#26 *Prompt practice*, and BCT#21 *Information on how to perform the behaviour*, appearing in ten out of the fourteen studies. The BCT#1 *Providing general information on the consequences of the behaviour*, evident in nine of the studies; and BCT#20 *Relating to information on where and when to perform a behaviour*, was used in four of the studies. BCT#2 *Providing information on the consequences of the behaviour specifically related to the individual*. Table 2 highlights the differences between the BCTs which feature more prominently in interventions where long term outcomes are reported, in comparison to the fifty-nine interventions overall. Table 2 illustrates that practical cooking experience is important in promoting behavioural change rather than watching cooking skill demonstrations that only model behaviour and provide direction on how to carry out the skills.

Theoretical Underpinning of Interventions

Theory was explicitly cited in fourteen of the fifty-nine interventions^[15, 19, 20, 21, 27, 28, 30, 33, 36, 37, 40, 42, 47, 51]. However, none of these papers reported how the chosen theory was used in the selection of the specific BCTs employed in the intervention, and no study linked the theory to the content

or outcomes. Of the fourteen interventions citing a theoretical framework in the intervention development, nine cited Social Cognitive Theory (SCT)^[15, 21, 27, 28, 30, 36, 40, 42, 47], two cited Social Learning Theory (SLT)^[33, 37]; one cited Experiential Learning Theory^[19]; one discussed Social Ecological Theory^[20], and one Social Marketing Theory^[51]. BCT#22 *Model or demonstrate the behaviour* was identified in 12 out of the 14^[All except 19, 30]; interventions citing explicitly a theoretical framework in the methodology. BCT#26 *Prompt practice* was identified in seven of the 14 theory-based interventions. Of these seven interventions; six involved BCT#22 and BCT#26 together^[All except 19]. There did not appear to be systematic differences in BCTs identified from explicitly theory-based interventions versus those interventions which did not state a theoretical framework in the design. Of the 14 studies which used theory in the intervention design, all indicated that primary outcomes were met and reported positive short-term gains (i.e., within three months). Only 3 out of the 14 studies reporting the use of theory in the design showed long-term positive outcomes (greater than three months) (*experiential learning theory*^[19]; *social ecological theory*^[21]; *social marketing theory*^[51]) whilst 11 of the studies^[18,23,24,50,52,54,57,58,64,65,66] which reported no theory, evidenced long-term positive outcomes. Therefore, no pattern was identified between theory based interventions, positive long term outcomes and inclusion of specific BCTs or combinations of BCTs.

DISCUSSION

This study identified and reviewed fifty-nine cooking and food skills interventions in relation to intervention design, identifiable BCTs, theoretical underpinnings and study outcomes. A more standardised approach with thought given to the theoretical framework underpinning behavioural

change may be more likely to promote consistency in the planning of BCTs used and the success of the intervention so that comparisons can be made.

Less than half of the fifty-nine interventions included in this study, contained practical or 'hands on' food preparation or cooking elements (coded as BCT#26 *Prompt practice*) as the main focus of the intervention. However, of those interventions reporting long term behavioural change, the majority included a practical skills element (BCT#26). Those interventions involving cooking demonstration only (BCT#22) reported no long term behavioural change. It may therefore be surmised that to increase the success rate of cooking interventions and maintain behavioural change in the long term, it is important to empower participants to become involved in practical hands on cooking sessions.

The majority of the interventions (fifty-five out of fifty- nine) involved populations in developed countries (thirty-one studies in USA, six studies in UK, four in Canada, three in Scandinavia, two in Italy, two in Japan, one in the Netherlands and one in the Republic of Ireland). Therefore, the results must be considered separately from those involving culturally disparate populations (e.g. South America, China, India and Indonesia) as replication of the same intervention within a different context may not yield similar results. The majority of interventions targeted vulnerable groups or those with health needs.

The majority of interventions identified between 4 -- 10 BCTs which focus on behaviour change related to providing information, or instruction and practice. Furthermore, BCT#1 (information on the consequences of the behaviour in general), BCT#21 (instruction on how to perform the behaviour) and BCT#26 (prompt practice) appeared across all interventions that were deemed successful in the long-term. Furthermore, BCT#2 (information on the consequences of the

behaviour tailored to the individual), and BCT#20 (information on when and where to perform the behaviour) were used in at least half of these successful interventions. Therefore, these BCTs should be used in the future design, planning and delivery of robust and effective cooking and food skills interventions to promote behaviour change.

In addition, the most common BCTs used were related to providing information on the consequences of a behaviour generally (BCT#1). Many interventions utilised general information-giving strategies such as providing nutritional education. Previous research has shown that knowledge is required as a basis to generate creativity and the application of skills^[74], therefore this information sharing can be considered an important constituent of cooking and food skills interventions. However, it is also generally accepted among behavioural science that information alone is not sufficient to change behaviour^[75]. A more holistic set of knowledge and skills related to nutrition, planning meals, food acquisition and social interaction is required for individuals to change their eating behaviour and develop skills in preparing healthy home cooked meals.

In the majority of the interventions where general information (#BCT1) was provided on the relationship between the behaviour and its likely consequences, for example how a diet high in fats or salt or sugar (HFSS), (#BCT2) was also present because the information was tailored to the specific needs of the groups. Such information tailoring can be argued to have a greater impact upon individuals, by increasing personal relevance, thus making behaviour change more likely^[76, 77].

BCT#26 *Prompt practice* was featured in thirty-nine interventions and captured those instances of carrying out a practical activity (e.g., food preparation/cooking), thereby offering an essential

form of skills development in the cooking and food skills domain. Studies in which social learning theory was present revealed the common use of (#BCT22), demonstration of cooking skills. However, none of the studies using this theory evidenced long term behavioural change.

Michie et al. (2011) argue that theory-based interventions are more likely to be effective if causal determinants of behaviour and behaviour change are targeted, but also claim that using a theoretical framework promotes better understanding of why interventions are effective and so create a foundation on which to develop improved interventions^[2, 76, 77]. This study where theory was evident, cites social cognitive theory most frequently, however it is apparent through analysis of these interventions that social cognitive theory is not a pre-requisite to determine positive long term outcomes. Although modelling skills did not promote long term behavioural change in these instances, it is necessary to consider testing these theories further on a larger sample, or examine an alternative theoretical basis on which to design successful cooking interventions exhibiting long term behavioural change. As previously mentioned although theory was explicitly detailed in interventions, they were not linked to specific BCTs indicating that further consideration of BCTs must be incorporated in the planning and design of cooking interventions.

Results indicated that BCT#20 *Provide information on when and where to perform the behaviour* and BCT#21 *Provide Instruction on how to perform the behaviour*; were often used together (22 out of 59 studies). The “*Food Cent\$*” intervention sessions participants are given information on how to carry out specific food skills (e.g. make a shopping list) (BCT#21) and where to access inexpensive ingredients (BCT#20)^[20]. Given these results, it would be appropriate to recommend incorporating both BCT#20 and BCT#21 into future CS and FS

interventions to maximise the chances of behaviour change. Providing instruction on *how* to perform the behaviour (e.g., cook a recipe in the group setting) in addition to information on *when and where* to perform the behaviour within a local community setting or within a personal routine (i.e., replicate the meal in the home environment) helps to increase the personal relevance of the message^[53, 54].

BCT#8 *Identify barriers/problem solving* may be of particular relevance for interventions related to the development of practical cooking and food skills, as external barriers such as time, budget and family preferences have been noted as strongly affecting the adoption of new skills and therefore moderating their potential impact upon diet^[1, 79]. The inclusion of BCT#9 alongside BCT#8 assists behaviour change as participants who have considered their personal barriers and possible solutions, can begin by first enacting small sub-stages of an overall goal (e.g., switching from deep-fat frying sausages to grilling them) before making bigger changes (e.g., replacing the sausages with healthier vegetarian equivalents cooked in the oven).

Strengths and Limitations

This research had a number of strengths and limitations. First, this study critically examined a totality of evidence from two recent home-food preparation and cooking intervention systematic reviews which were rigorously conducted and included cooking and food skills interventions from across the globe^[13, 14]. We are confident that given the recency and robustness of these studies, this critique of cooking and food skills interventions has included a representative sample of interventions. The review benefitted from the input of coders who were experienced in the use of BCTs and intervention development and had undertaken extensive training online in advance using the BCT Taxonomy v1 programme available from <http://www.bct->

taxonomy.com/. In addition, it was possible to contact the authors of the taxonomy to seek clarification around any BCT classifications, where there was disparity between coders or ambiguity around taxonomy wording such as for BCT#26 *Prompt practice* which provided rigour to the BCT mapping exercise.

The forty item CALO-RE taxonomy^[2] was utilised in this study, however an updated ninety-three item taxonomy is available^[3]. The ninety-three item taxonomy may be suitable for use in offering a more detailed breakdown of a lesser number of studies which potentially may offer a more prescriptive conclusion in terms of effective BCTs for future cooking skills interventions. The BCTs discussed here are based upon the written information which was available in the articles or reports retrieved, and it is possible that additional BCTs were involved in the interventions which were not adequately described in the published reports. However, given the discernible patterns of BCTs identified across multiple and global cooking and food skills interventions, we can be somewhat reassured that the findings indeed reflect the true intervention content. Similarly, in relation to theory, only fourteen of the fifty-nine interventions reported explicitly following a theoretical framework in the design of the intervention, yet none discussed this explicitly in terms of their selection of intervention strategies or BCTs. It is possible that other interventions used theory in the design and selection of intervention strategies yet did not report this, therefore perhaps leading us to under-estimate the true impact of theoretically designed behaviour change interventions. It is also worth noting that none of the BCTs identified across all fifty-nine interventions were explicitly described as ‘BCTs’, despite nine interventions being published following the dissemination of the first BCT taxonomy in 2008. Thus researchers need to be encouraged to use Michie’s CALO-RE taxonomy in designing

interventions in all areas of research and share evidence relating to behaviour change, regardless of the specific behaviours or the intervention domain.

Finally, it should be noted that despite the reasonable number of interventions used in this examination ($n = 59$), almost all interventions were conducted using developed populations, limiting the generalisability of the results beyond these groups. The scope of this review may be widened to include more recent international cooking skills intervention studies. Furthermore, the findings of the primary studies contained ($n = 59$) were typically self-reported measures, and therefore the usual caution must be noted with regard to social desirability of the findings.

CONCLUSION

By identifying and highlighting these BCTs and critiquing intervention designs this paper offers a robust and standardised cooking and food skills intervention design template for future studies in this area. These findings should facilitate the replication and adoption of effective BCTs into future cooking and food skills interventions to maximise intervention efficacy, with positive impacts on diet quality.

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Table 1 Summary of Cooking Intervention Outcomes

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post-measure) 1 = Yes 2=NO | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|---|---------|----------|-------------|--------------------------------|--------|--------------------|------|--|--|---|---------------------------|--|---|-------------------------------------|
| Brown & Richards (2010) ^[15] | US | Pre/post | 616 | General pop. | Mixed | 1 | CS | To increase variety of meals | 1 | 3 | 1 | 1 | 2 | none |
| Lacey (2007) ^[16] | US | Post | 55 | General pop. | Female | 1 | CS | To introduce a range of cereal products | 1 | 3 | 1 | 1 | 2 | none |
| Abbott et al., (2010) ^[17] | AUS | Post | 23 | Cultural group | Mixed | 29 | FS | To apply NK and FS to daily lives and the wider family | 2 | 2,3 | 2 | 2 | 2 | none |
| Davies et al., (2009) ^[18] | UK | Pre/post | 46 | Cultural group | Mixed | 28 | FS | To engage Asian groups to healthy eating practices | 3 | 3 | 1 | 1 | 1 | none |
| Swindle et al (2007) ^[19] | US | Pre/post | 53 | Low-income & vulnerable groups | Mixed | 6 | FS | Measure the impact of "eating right" | 1 | 3 | 1 | 1 | 1 | EL |
| Shanker et al (2006) ^[20] | US | Pre/post | 212 | Cultural group | Female | 6 | FS | Increase FV consumption among African American women | 1 | 2,3 | 1 | 1 | 2 | SET |
| Newman et al.,(2005) ^[21] | US | Pre/post | 739 | Health needs | Female | 12 | FS | To Introduce plant based foods | 1 | 2 | 1 | 1 | 1 | SCT |
| Woodson et al (2005) ^[22] | US | Pre/post | 485 | Cultural group | Mixed | 6 | FS | Promotion of nutritional info | 1 | 3 | 1 | 1 | 2 | none |
| Brown & Herman (2005) ^[23] | US | Pre/post | 602 | General pop. | Mixed | 8 | FS | Increase FV in young adults | 1 | 2 | 1 | 1 | 1 | none |
| Keller et al., (2004) ^[24] | CAN | Pre/post | 29 | Low-income & vulnerable groups | Male | 8 | CS | Increase nutritional well-being of older males | 3 | 3 | 1 | 1 | 1 | none |

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post-measure) 1 = Yes 2=NO | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|--|---------|----------|-------------|--------------------------------|--------|--------------------|------|---|--|---|---------------------------|--|---|-------------------------------------|
| Foley and Pollard (1998) [25] | AUS | Pre/post | 612 | Low-income & vulnerable groups | Mixed | 4 | FS | Reduce cost of healthy household shopping | 1 | 2,3 | 1 | 1 | 2 | none |
| Ranson (1995) [26] | AUS | Pre/post | 60 | General pop. | Male | 4 | CS | Promote cooking confidence in men | 3 | 3 | 1 | 1 | 2 | none |
| Chapman-Novakofski & Kardock (2005) [27] | US | Pre/post | 239 | Health needs | Mixed | 3 | NK | Increase food choices to those with diabetes | 1 | 3 | 1 | 1 | 2 | SCT |
| Herman et al. (2000) [28] | US | Pre/post | 76 | General pop. | Mixed | 8 | CS | Promote nutritional application in food choices and cooking | 1 | 1,2 | 1 | 1 | 2 | SCT |
| Mc Murray et al. (1991) [29] | US | Pre/post | 336 | Health needs | Mixed | 6 | FS | Promote nutritional information and its application | 1 | 3 | 1 | 1 | 2 | none |
| Condasky (2010) [30] | US | Pre/Post | 29 | Family | Mixed | 6 | CS | Formative analysis of the "Cooking with a Chef" project | 3 | 3 | 1 | 1 | 2 | SCT |
| Wrieden et al.,(2007) [31] | UK | NRC | 113 | Low-income & vulnerable groups | Mixed | 7 | CS | Using "Cookwell" to promote healthy eating | 2 | 3 | 1 | 1 | 2 | none |
| Kennedy et al.,(1998) [32] | UK | NRC | 26 | Low-income & vulnerable groups | Female | 10 | FS | Increase NK of domestic food practices | 3 | 2,3 | 1 | 1 | 2 | none |
| Auld & Fulton (1995) [33] | US | NRC | 29 | Low-income & vulnerable groups | Female | 5 | CS | Increase the use of commodity foods | 1 | 2 | 1 | 1 | 2 | SLT |

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post-measure) 1 = Yes 2=NO | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|--------------|---------|--------|-------------|-------------|--------|--------------------|------|-----|--|---|---------------------------|--|---|-------------------------------------|
| | | | | | | | | | | | | | | |

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|---|------|-----|-------|--------------------------------|--------|----|----|--|---|--------|---|---|---|------|
| Jacoby et al (1994) ^[34] | S Am | NRC | 143 | Low-income & vulnerable groups | Female | 1 | FS | improve awareness of food preparation practices in terms of weaning | 1 | 3 | 1 | 1 | 2 | none |
| Mc Keller et al.,(2007) ^[35] | UK | NRC | 130 | Health needs | Female | 6 | FS | investigate the impact of a Mediterranean style diet on patients with arthritis | 1 | 1,2 | 1 | 1 | 2 | none |
| Clifford et al., (2009) ^[36] | US | RC | 101 | General pop. | Mixed | 4 | FS | assess the impact of TV cooking shows on cooking motivation & learning | 1 | 3 | 1 | 1 | 2 | SCT |
| Levy & Auld (1995) ^[37] | US | RC | 65 | General pop. | Mixed | 4 | CS | determine if cooking sessions improve knowledge attitudes, efficacy and behaviour | 1 | 3 | 1 | 1 | 2 | SLT |
| Karevetti, (1981) ^[38] | SCD | RC | 272 | Health needs | Male | 15 | FS | assess the benefit of cooking dem. on NK & self-efficacy | 1 | 3 | 1 | 1 | 2 | none |
| Flesher et al. (2011) ^[39] | CAN | RC | 40 | Health needs | Mixed | 17 | CS | measure the impact/ individual nutritional advice, cooking and exercise classes vs standard care | 2 | 3 | 1 | 1 | 2 | none |
| Adam et al (2015) ^[40] | US | NRC | 7,422 | General pop. | Mixed | 5 | CS | Online course/ cooking instruction to improve eating behaviour | 1 | 3 | 1 | 1 | 2 | SCT |
| Anderson et al (2015) ^[41] | US | NRC | 95 | Low-income & vulnerable groups | Mixed | 16 | CS | Cooking and exercise to build self-efficacy and build intrinsic motivation for health | 1 | 1,3 | 1 | 1 | 2 | none |
| Archuleta et al (2013) ^[42] | US | NRC | 117 | Health needs | Mixed | 3 | CS | Do cooking classes improve nutrient intake in people with type 2 diabetes | 1 | 1,2,3, | 1 | 1 | 2 | SCT |

| | | | | | | | | | | | | | | |
|--|-------|-----|------|--------------|-------|----|----|--|---|-------|---|---|---|------|
| Balogopal et al (2012) ^[43] | India | NRC | 1638 | General pop. | Mixed | 10 | FS | To test the impact of a 6 month community based diabetic prevention program in rural India | 3 | 1,2,3 | 1 | 1 | 2 | none |
| Bielamowicz et al (2013) ^[44] | US | NRC | 2853 | Health needs | Mixed | 3 | FS | determine the impact of a community diabetes project in improving cooking practices | 3 | 2,3 | 1 | 1 | 2 | none |

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post-measure) 1 = Yes 2=NO | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|--|---------|---------------------|-------------|--------------------------------|--------|--------------------|------|--|--|---|---------------------------|--|---|-------------------------------------|
| Carmody et al (2012) ^[45] | US | RC | 36 | Health needs | Male | 11 | CS | determine the impact of diet on prostate cancer | 1 | 1,2,3 | 1 | 1 | 2 | None |
| Chung et al (2014) ^[46] | China | NRC | 60 | Low-income & vulnerable groups | Mixed | 3 | CS | the effect of a cooking class n on the diets of the elderly | 3 | 1,3 | 1 | 1 | 2 | None |
| Condrasky et al (2013) ^[47] | US | Pre/post | 114 | Cultural group | Mixed | 1 | FS | assess a modified version of 'cooking with a chef' programme | 3 | 3 | 2 | 1 | 2 | SCT |
| Dasgupta et al (2012) ^[48] | CAN | Pre/post | 75 | Health needs | Mixed | 15 | FS | imporove Glycemic and blood pressure | 1 | 1 | 1 | 1 | 2 | None |
| Fahmida et al (2015) ^[49] | Insa | Pre/post | 494 | Family | Female | 6 | FS | Improving NK and feeding practices | 1 | 1,2,3 | 1 | 1 | 2 | None |
| Flynn et al (2013) ^[50] | US | Pre/post assessment | 63 | Low-income & vulnerable groups | Mixed | 6 | FS | improve food purchases and eating habits | 1 | 1,2 | 1 | 1 | 1 | None |
| Francis et al (2012) ^[51] | US | Pre/post assessment | 21 | General pop. | Mixed | 4 | NK | increase familiarity to the "heart healthy lifestyle " | 1 | 1,3 | 1 | 1 | 1 | SMT |

| | | | | | | | | | | | | | | |
|---------------------------------------|----|----------|----|--------------------------------|--------|---|----|--|---|-----|---|---|---|------|
| Garcia et al (2014) ^[52] | UK | Pre/post | 44 | Low-income & vulnerable groups | Mixed | 8 | CS | evaluate impact of programme on confidence and food eating habits | 1 | 2,3 | 1 | 1 | 1 | None |
| Goheer et al (2014) ^[53] | US | Pre/post | 78 | General pop. | Mixed | 6 | FS | nutrition class to reduce obesity and risk of heart attack in firefighters | 1 | 2,3 | 1 | 1 | 2 | None |
| Greenlee et al (2015) ^[54] | US | RCT | 70 | Health needs | Female | 9 | FS | examine the effect of culturally-based approach to dietary change | 1 | 2 | 1 | 1 | 1 | None |

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post-measure) 1 = Yes 2=NO | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|--------------------------------------|---------|----------|-------------|--------------------------------|--------|--------------------|------|---|--|---|---------------------------|--|---|-------------------------------------|
| Hanson et al (2011) ^[55] | US | Pre/post | 40 | Low-income & vulnerable groups | Mixed | 7 | FS | investigate the impact of nutrition knowledge on diet | 3 | 2 | 1 | 1 | 2 | None |
| Hearst et al (2014) ^[56] | US | Pre/post | 25 | Cultural group | Female | 4 | CS | parent-centred work to increase fruit and veg intake | 3 | 2 | 1 | 1 | 2 | None |
| Herbert et al (2014) ^[57] | AUS | Pre/post | 140 | General pop. | Mixed | 10 | FS | The impact of Jamie's Ministry of Food to healthy cooking | 3 | 2,3 | 1 | 1 | 1 | None |
| Hossain et al (2015) ^[58] | AUS | Pre/post | 176 | Low-income & vulnerable groups | Mixed | not stated | CS | Impact of the Red Apple Healthy Lifestyles programme | 1 | 2,3 | 1 | 1 | 1 | None |
| Kitaoka et al (2013) ^[59] | Japan | NRC | 71 | Health needs | Male | 5 | CS | Impact of cooking classes on lifestyle change | 1 | 3 | 1 | 1 | 2 | None |
| Kwon et al (2015) ^[60] | Japan | RCT | 89 | Low-income & vulnerable | Female | 12 | FS | The impact of physical exercise | 3 | 3 | 1 | 1 | 2 | None |

| | | | | | | | | | | | | | | |
|--|-----|----------|-----|--|-------|----|----|---|---|-----|---|---|---|------|
| | | | | groups | | | | and nutrition classes | | | | | | |
| May et al (2014) ^[61] | US | Pre/post | 45 | Low- income & vulnerable groups | Mixed | 6 | CS | online curriculum to improve cooking and shopping skills | 3 | 2,3 | 1 | 1 | 2 | None |
| Mayfield et al (2014) ^[62] | US | Pre/post | 446 | Family | Mixed | 1 | FS | increase nutrition knowledge and dietary behaviours | 1 | 3 | 1 | 1 | 2 | None |
| McGorrian et al (2015) ^[63] | ROI | RCT | 116 | Health needs | Mixed | 5 | CS | examine the effects of a novel Cookery skills class on BMI | 1 | 1 | 1 | 2 | 2 | None |
| Penn et al (2013) ^[64] | UK | Pre/post | 218 | Health needs | Mixed | 20 | CS | To assess feasibility of a cooking skills class on lifestyle change | 3 | 1,2 | 1 | 1 | 1 | None |

| Intervention | Country | Method | Sample size | Target Pop. | Gender | Number of sessions | Type | Aim | Results reported 1=quant 2=qual 3=mixed | Outcomes 1=Health 2=Dietary Behaviour 3=Psych. | Aim met? 1=Yes 2=NO | Positive Short term (pre & post- measure) | Positive Long term effects >3mths 1 = Yes 2=NO | Theory Explicit in the Study Design |
|---------------------------------------|---------|----------|----------------|--|--------|--------------------------|------|---|---|--|------------------------------|--|--|---|
| Peters et al (2014) ^[65] | US | RCT | 71 | General pop. | Female | 24 | CS | Study the pattern of dietary change following a cooking skills class | 1 | 2 | 1 | 1 | 1 | None |
| Pluss et al (2011) ^[66] | SCD | RCT | 224 | Health needs | Mixed | 3 | CS | investigate the long term effect of expanded cardiac rehab on patients | 1 | 1 | 1 | 1 | 1 | None |
| Poelman et al (2015) ^[67] | NL | RCT | 278 | Health needs | Mixed | 1 | FS | determine the effect of the PortionControl@HOME on BMI | 1 | 1,2 | 1 | 1 | 2 | None |
| Rustad et al (2013) ^[68] | US | Pre/post | 118 | Low- income & vulnerable groups | Female | 3 | FS | assess the impact of a short term nutritional class on dietary behaviour | 1 | 2,3 | 1 | 1 | 2 | None |
| Sorensen et al (2011) ^[69] | CAN | RCT | 56 | Health needs | Mixed | 10 | FS | Impact of cc on BMI | 1 | 1 | 1 | 1 | 2 | None |
| Vadstrup et al (2011) ^[70] | SCD | Pre/post | 143 | Health needs | Mixed | 3 | FS | investigate effects of group- rehab vs | 1 | 1,3 | 1 | 2 | 2 | None |

| | | | | | | | | | | | | | | |
|---|-------|----------|-----|--------------|--------|------------|----|--|---|-----|---|---|---|------|
| | | | | | | | | individual counselling | | | | | | |
| Villarini et al (2012) ^[71] | Italy | Pre/post | 96 | Health needs | Female | not stated | FS | investigate the impact of a dietary class on BMI | 1 | 1 | 1 | 1 | 2 | None |
| Villarini et al (2015) ^[72] | Italy | Pre/post | 186 | Health needs | Mixed | 5 | FS | Investigate the effect of the health education on lifestyle Metabolic Syndrome | 1 | 1 | 2 | 2 | 2 | None |
| Wunderlich et al (2011) ^[73] | US | Pre/post | 355 | General pop. | Mixed | 8 | FS | investigate the impact of NK on dietary behaviour | 1 | 1,2 | 1 | 1 | 2 | None |

Key

| | | | | | | | |
|------|---------------------|-----|--------------------------|------|------------------------------|-----|-------------------------|
| AUS | Australia | SAM | South America | RCT | Randomised control test | SET | Social ecology theory |
| CAN | Canada | SCD | Scandinavia | NRCT | Non-Randomised control test | SLT | Social learning theory |
| INSA | Indonesia | UK | United Kingdom | SCT | Social cognitive theory | SMT | Social marketing theory |
| NL | Netherlands | US | United States of America | EL | Experiential learning theory | | |
| ROI | Republic of Ireland | | | | | | |

Table 2 Comparison between the Percentage of Most Commonly Occurring BCTs in all Fifty-Nine Interventions and Fourteen Reporting Long Term Behavioural Change

| Behavioural Component Technique | Percentage of all 59 Interventions where BCT was used | Percentage of 14 Interventions Reporting Long Term Behavioural Change where BCT was used |
|---|--|---|
| 1 - <i>General information giving</i> | 98 | 64 |
| 2 -- <i>Information giving specific to the individual</i> | 41 | 21 |
| 20- <i>Where and when to carry out the task</i> | 0 | 28 |
| 21- <i>How to carry out the task.</i> | 76 | 71 |
| 22 -- <i>Demonstrate the task.</i> | 66 | 0 |
| 26- <i>Prompt practise/practical cooking</i> | 44 | 71 |

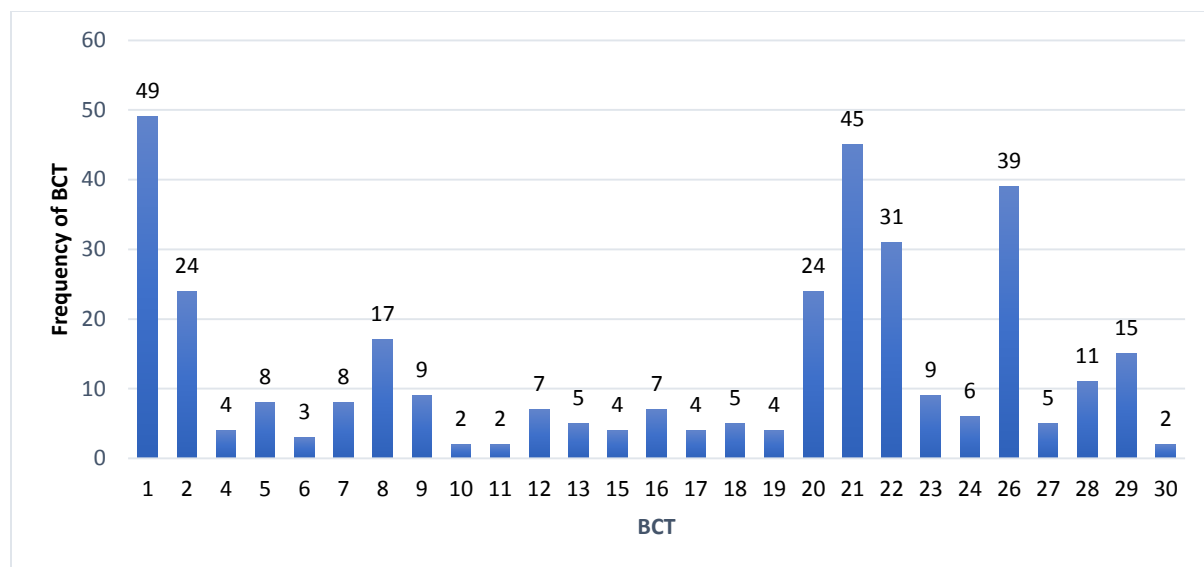


Figure 1 Frequency of Identified BCTs across all Fifty-Nine Cooking Interventions