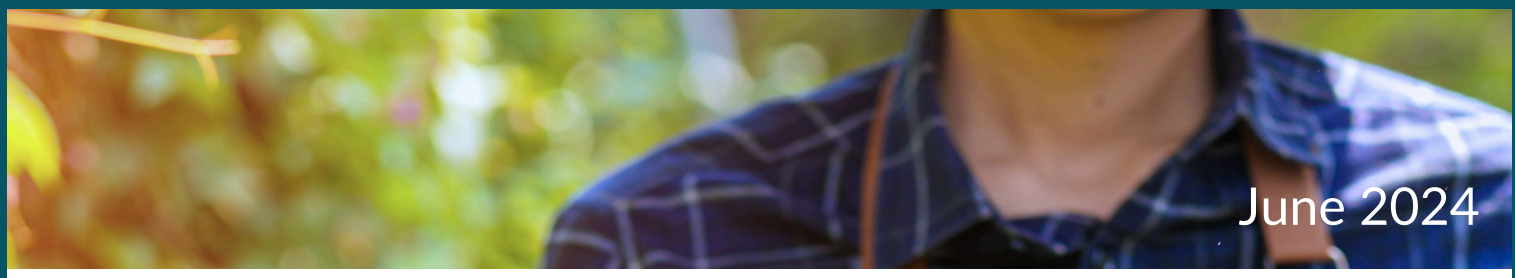

June 2024

Community healthy food interventions:
Review of outcome metrics and toolkits

Report for Cornwall Council and the WellFed Cornwall Network

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About WellFed Cornwall

WellFed Cornwall is a network of community food growers, social prescribers, clinicians, public health professionals, diabetes nurses, health coaches, voluntary sector partners and researchers. They are working together to tackle malnutrition, diabetes, obesity, poor mental and physical health, loneliness, and anxiety. They are developing a series of pilot programmes to bring health systems and food systems together. These programmes include veg box prescription, cooking groups and recipe cards, community gardening groups, supporting food banks, and measuring the outcomes of healthy food interventions. For further details see: WellFed Cornwall

About CAST

Led by the University of Bath, the UK Centre for Climate Change and Social Transformations (CAST) is a collaboration between Bath, Cardiff, Manchester, York, and East Anglia universities, and the charity Climate Outreach. The Centre aims to be a global hub for understanding the profound changes required to address climate change. We research and develop the social transformations needed to produce a low-carbon and sustainable society. Our experts include psychologists, sociologists, political scientists, engineers and organisational specialists working across multiple scales (individual, community, organisational, city-region, national and global) to identify and experiment with various routes to achieving lasting change. CAST is funded by the Economic and Social Research Council (ESRC). For further details see: https://cast.ac.uk/

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Summary

The escalating prevalence of diet-related chronic diseases coupled with growing concerns about environmental sustainability have led to an interest in diet interventions as one route to health creation. These interventions aim to support target social groups, improve dietary behaviours, and mitigate the burden of chronic disease. In some instances, they also strive to promote environmentally sustainable food systems. Diet interventions are typically implemented at the community level where public health and social care services can engage with individuals and adapt their programmes based on local needs or existing community networks. Examples include vouchers to buy fruit and vegetables from local farmers' markets, and social prescribing of veg boxes and cooking classes.

One challenge facing health care professionals, local authorities, food growers, and charities or voluntary sector organisations that are trialling community food interventions is how to measure and evidence the outcomes. The aim of this review is therefore to identify a range of evaluation metrics and toolkits that are used in community-based diet interventions, with a focus on health, climate, and community benefits, as shown in the figure below.

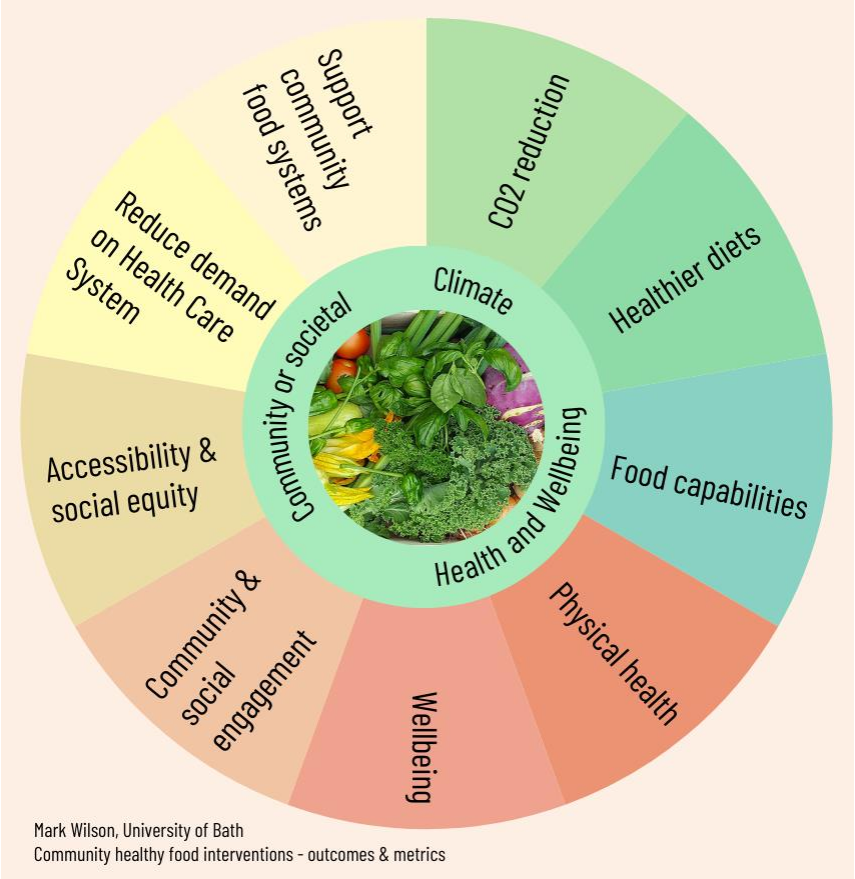

Figure 1, Potential outcomes of community healthy food interventions

The outer ring[1] of Figure 1 shows nine broad impacts or assessment areas that were identified by WellFed Cornwall stakeholders as potentially relevant for evaluating the outcomes of their healthy food social prescribing pilots. These impacts determined the scope of this review. The review does not appraise individual metrics, scales or toolkits, although some of the reviewed studies do discuss the relative advantages and disadvantages of using a particular metric. The review is comprehensive, although not exhaustive, given the broad scope of the nine assessment areas.

This report is structured as follows; Chapter 1 describes how the review was conducted. Chapters 2 and 3 consider how dietary shift and changes in food practices or competences are measured, reflecting two key components of healthy food interventions. Chapter 4 reviews the health and wellbeing outcomes for the target social groups. Chapters 5, 6 & 7 present metrics associated with community or societal co-benefits, such as carbon emission reduction, increased social interaction and community engagement, and support for food growers and local businesses. Chapter 8 discusses approaches for evaluating participation in community food interventions, for the intended beneficiaries but also health and social care practitioners. The report is focused primarily on metrics, although each chapter concludes with a table presenting toolkits which practitioners or community-based organisations use to guide and deliver their programmes.

Table 1 sets out the main findings and suggestions for measuring the outcomes of social prescribing of healthy food, within each assessment area, based on the evidence reviewed.

Table 1. Headline findings from the review

Metric	Common measures based on literature review	Feasibility assessment	Suggested adaptation for project if applicable
Shifts to healthier diets	Quantitative self-report measures remain most common diet intake metrics (e.g. Food Frequency Questionnaires, 3/7-day food diaries and 24-hour dietary recalls) (Kelly et al., 2013; Simmet et al., 2017; Ciliska et al., 2000). In addition to food intake, other metrics may be taken into account, e.g. weight/ amount/ timing/ location of meals (Lashkarboulok et al., 2022);	Potential bias and inaccuracy using self-report (e.g. underreporting, missing data) especially if measures are complex or time/labour-intensive (Hendrie et al., 2017). For vulnerable populations, Food Frequency Questionnaire and Screener methods are least cognitively demanding (Thompson et al.,	— 3-day food diary at baseline & end-of project — Photos of food with food diary — 24-hour dietary recall in regular survey — Brief Food Frequency Questionnaire or simpler 24-hour dietary recall may be easy to use

[1] Outcomes and Metrics figure adapted from: Sustainable Food Cornwall and the University of Exeter (2023). Community Growing in Cornwall - The impact and potential of local sustainable food growing in Cornwall. Figure 2: The overlapping benefits generated by community growing schemes

	budget and purchasing (Engel & Ruder, 2020). In general, self-report is less accurate than biomarkers Johnson, 2002). Digital tools may improve accuracy of measures but are still subject to biases and inaccuracy (Ho et al., 2020; Ngo et al., 2009). Visual measures may improve accuracy in some interventions (Fontana et al., 2020). Diet and environmental indicators are typically measured in parallel (Guo et al., 2022).	2015); participant preference for 24-hour dietary recall or Food Frequency Questionnaire (Vucic et al., 2009; Franck et al., 2023); self-report methods (food diaries) preferred by participants over diet photo record or weighed food (Muller-Stierlin et al., 2021). Recall methods may be too taxing and reliant on interviewers. Image based measures may be more accurate than self-report but this depends on the specific methods and reviewers disagree on which methods are most accurate (Fontana et al., 2020; Hochsmann, 2020). Food diary & photo record found to be feasible and acceptable for assessing dietary intake in vulnerable populations. However, the methods should be simple and concise. Computerised assessments and personal digital assistants may be the most feasible digital methods with vulnerable populations (Ngo et al 2009).	and cost-effective (Vucic et al., 2009) — Food diary records, especially if easy to record (e.g. documenting visually rather than in text) — Food records could be preferable to participants if kept simple. — Screeners could be useful but are less detailed so would need to be used in combination with other measures.
Change in food practices	Measures and metrics overlap with and extend beyond food intake (e.g. food preparation and cooking practices, food waste and sustainability practices, food security and access). A wide range of measures and metrics have been used, which are typically tailored to the intervention and involve quantitative and qualitative methods. Outcomes often combine self-report, biomarker and anthropometric measures (Hasan et al., 2019; Farmer et al., 2018). Standardised measures exist, e.g. Nutrition Environment Measures Survey (Papanek et al., 2023)	Cardiometabolic and/or behavioural outcome measures would be feasible. The former if collected by GP of health professional. The latter using self-report (see above).	— A simple quantitative instrument could be used to generate responses to food practice change, along with a subset of interviews/focus groups
Physical health	Anthropometric measures (e.g. Body Mass Index (BMI), body fat, weight, etc).	Check with GPs and health professionals for feasibility.	— BMI — Weight — Blood pressure

	Common use of BMI and waist circumference (Sommer et al., 2020). Middle-upper arm circumference, weight-for-height and waist circumference are reliable short-term indicators of malnutrition (Frison et al., 2016). There are a range of biomarkers (e.g. blood test, blood sugar, cholesterol, inflammation markers) (Cook et al., 2021)	Carotenoids may be useful marker for fruit and vegetable consumption (Baldrick et al., 2011).	— Cholesterol — Carotenoids — Blood sugar/glucose
Mental health and wellbeing	There is a huge range of Quality of Life & Wellbeing scales, with considerable confusion over the definition and operationalisation of terms. Commonly used quantitative scales include SWEMWBS (Polley et al., 2021); Short Form–36 Health Survey (Carson et al., 2014); Hospital Anxiety and Depression Scale, SWEMWBS and General Health Questionnaire 12 (Pescheny et al., 2020)	Some scales are very long and therefore not feasible for use. However, plenty of shorter scales are available. Including a subset of qualitative interviews could also help increase detail. One scale could be used to gauge mental and physical wellbeing.	— 14-item Warwick Edinburgh Mental Wellbeing Scale (WEMWBS). Or the short 7-item Scale (SWEMWBS) — General Health Questionnaire 12 — Hospital Anxiety & Depression Scale (12 items)
Carbon emission reduction	Interventions have sometimes used modelling to estimate carbon emissions from diet change; otherwise a range of electronic carbon footprint calculators are available (Dreijerink & Paradies, 2020) including specific versions for diet, though these have limitations in their coverage (Kimm & Neff, 2001). No common standard measure emerged from the review.	A simple carbon footprint calculator could be feasible for use with the population. Alternatively, carbon emissions could be calculated from diet change metrics and approximated, without adding to the burden and risking missing data for participants.	— Carbon footprint calculators have their limitations and so emissions may be better calculated from food intake (or related metrics).
Community engagement & social outcomes	Covers a range of methods, including community surveys, interviews, empowerment and capacity building metrics, Social Network Analysis. Importance of designing and operationalising engagement outcomes. Can cover context (assessing conditions under which intervention occurs), process (how engagement with the intervention occurred), and outcome (impact of the research on the community) (Milton et al., 2012).	A standardised measure could be used along with qualitative interviews, though it is difficult to identify the former. Co-design could be included as a principle, though this would be limited with the population. However, it could be done with stakeholders and standardised metrics (e.g. Community Engagement in Research Index, Community Research Engagement Assessment Tool, Program for	— Perhaps design a tailored measure alongside qualitative interviews? — Process measure for stakeholders/other groups? (Community Engagement in Research Index etc.) — Social Network Analysis (built into surveys) to track changes in social networks over time.

	No common standard measure emerged from the review. Relevance of co-design as an essential ingredient for successful interventions (Luger et al., 2020)	the Elimination of Cancer Disparities (Luger et al., 2020).	
Support for growers/ businesses	Less evidence for outcomes in support of food producers/businesses, and no common standard measure. Community Supported Agriculture (CSA) as a promising source for measures and metrics - mainly comprising surveys, interviews with producers, infrastructure and provision (e.g. count of CSA partners/farms) and financial metrics such as grocery store receipts, sales, rescued/reappropriated food, cost-revenue estimates (Vasquez et al., 2017; Gittelsohn et al., 2013). Availability of audit tool, e.g. Nutrition Environment Measures Survey (Martinez-Donate et al., 2013).	Feasibility of cost-revenue analyses, production capacity, other financial metrics may be limited to grocery receipts or broad measures of supply/demand. Surveys/interviews may serve as a proxy for producer support change.	— Surveys interviews with local community food producers/businesses — Audit tool (e.g. Nutrition Environment Measures Survey) could be used for more detailed analysis.
Clients' experience of taking part	As above, little evidence for standardised and commonly used measures of client experience - though many interventions include participant experience evaluation, often using qualitative methods (Tay et al., 2021).	Who is included (beyond participants)? This will dictate feasibility to some degree. It would be straightforward to build an experiential component into the survey or interview, though a tailored measure would seem appropriate. There is also some overlap with process outcome evaluation	— Tailored measures built into surveys and interviews (if used)

Contents

1.0. Introduction

This report aims to inform the selection of evaluation methodologies and the development of metrics for rigorous and robust measurement of health, sustainability, and community/societal outcomes brought about by community-based diet interventions. Seven broad assessment areas or indicators were identified by WellFed Cornwall stakeholders as potentially relevant for evaluating the outcomes of healthy food interventions. These indicators determined the scope of this review:

1. Shifts to healthier diets
2. Change in food practices
3. Physical and mental health/wellbeing
4. Carbon emission reduction
5. Community engagement/social outcomes
6. Support for growers/businesses
7. Clients' experience of taking part

The indicators are characterised by a plurality of evaluation approaches and metrics, and there is significant crossover between them. Metrics summarised under one indicator are often relevant to other indicators and we have attempted to highlight this in the text. The review does not attempt to provide a synthesis of the metrics, but to identify those that have been used in diet interventions, particularly within community contexts in the UK or US.

In conducting this review, we acknowledge the interconnections between dietary behaviours, health outcomes, and environmental sustainability. While some studies have demonstrated the effectiveness of community-based interventions in improving dietary behaviours and health outcomes, there is a pressing need to assess their wider impact using sustainability metrics, such as greenhouse gas emissions (as well as other metrics including water usage and biodiversity conservation), and metrics linked to community engagement or supporting food growers.

The dynamic and context-specific nature of community settings also highlights the importance of employing contextually relevant and culturally sensitive evaluation metrics that capture these dimensions. Failure to account for these multifaceted considerations may undermine effective evaluation of interventions in place- or culture-specific contexts.

1.1. Review questions

The scoping review set out to address the following three questions:

- What outcome evaluation metrics exist for the purpose of measuring the seven indicators?
- Which outcome evaluation metrics have been used in previous interventions, particularly, community-based diet interventions?
- What resources or toolkits are used by health care practitioners and community-based organisations to inform or guide their diet interventions?

1.2. Literature search

To ensure comprehensiveness and relevance within the limits of the scoping review, a systematic approach was employed. The search strategy encompassed three primary sources: Scopus, Google Scholar, and targeted Google searches. Each platform offered distinct advantages in accessing a broad spectrum of scholarly articles and grey literature germane to the research objectives.

- **Scopus**: A comprehensive multidisciplinary database was utilised as a primary source for academic literature. Advanced search functionalities allowed the conducting of structured queries using relevant keywords and Boolean operators to refine results. The inclusion of Scopus facilitated access to peer-reviewed journals, conference proceedings, and citation metrics, enhancing the rigor and reliability of the scoping review.
- **Google Scholar**: An expansive coverage of scholarly literature across disciplines, which served to identifying both peer-reviewed and grey literature, and an array of academic sources, including articles, theses, preprints, and institutional repositories.
- **Google Search**: In addition to academic databases, targeted Google searches were conducted to capture evaluation toolkits, supplementary materials, reports, and industry insights not indexed in traditional scholarly repositories. This approach augmented the breadth of our literature search, enabling the identification of relevant grey literature, government publications, and expert opinions.

1.3. Search criteria

The search strategy encompassed free-text keywords relevant to the research focus. Boolean operators (e.g. AND, OR, NOT) were employed to refine search queries and enhance precision. The search criteria were adapted iteratively based on preliminary findings to ensure focus and relevance. Keywords included terms relevant to the

intervention (e.g. ‘intervention’, ‘programme’, ‘social prescribing’, ‘project’, initiative’, ‘toolkit’), level of the intervention (e.g. ‘community’, ‘local’), and indicators (e.g. ‘diet’, ‘food’, ‘health’, ‘wellbeing’, ‘sustainable’, ‘carbon emissions’, ‘business’, ‘producers’, ‘agriculture’, ‘food system’ and ‘participant experience’.

1.4. Inclusion and exclusion criteria

To maintain relevance and quality standards, inclusion and exclusion criteria were established a priori. Only English-language publications within a specified timeframe (post-1990) were considered for inclusion. Peer-reviewed articles, conference proceedings, dissertations, and reputable grey literature sources were eligible for inclusion, as were non-academic intervention websites, toolkits, and reports.

After screening, 393 articles and sources were retained. Where possible, we have focused on academic reviews covering outcome metrics.

2.0. Diet and food intake measures and metrics

2.1. Introduction

Assessing dietary intake constitutes a fundamental metric for evaluating the effectiveness of community diet interventions. Various measures have been used to quantify changes in dietary intake, patterns, and quality among participants, to inform intervention outcomes and strategies for behaviour modification and promotion of healthy/sustainable diets.

Within the reviewed literature, metrics typically focused on dietary surveys and diversity indices. Retrospective, self-report methods constitute the most common, and cost-efficient ways for assessing changes in dietary intake, for example, food frequency questionnaires (FFQs), periodic (e.g. 24-hour) dietary recalls, and food diaries. FFQs capture dietary intake over a specified period. Conversely, 24-hour dietary recalls and food diaries offer more detailed snapshots of food consumption on specific days, enabling more granular assessments of nutrient intake and meal composition.

Dietary diversity indices (DDI) assess the variety and adequacy of food consumed within different food groups, reflecting assessments of the overall balance and nutritional quality of participants' diets, such as the Healthy Eating Index (HEI), the Mediterranean Diet Score (MDS), and the Diet Quality Index (DQI). DDIs can measure both qualitative aspects (e.g., visual record of diversity of food groups) and quantitative aspects (e.g., portion sizes) of dietary intake, providing a more comprehensive assessment of dietary diversity, and adherence to dietary patterns associated with specific health outcomes (such as diabetes or coronary heart disease) than self-report methods.

Other DDIs have been used for the purpose of nutrient analysis. This involves quantifying the nutrient content of dietary intake (measured either subjectively or objectively) based on food composition databases and nutritional guidelines, allowing for the estimation of energy intake, macronutrient distribution, and micronutrient adequacy. Nutrient analysis can provide more objective measures of dietary change and enables comparison with recommended dietary intakes to identify areas for dietary improvement.

Other dietary assessment metrics also exist, including less standardised, more qualitative, self-reported dietary behaviours and adherence to dietary recommendations.

2.2. Review of the evidence on diet measures and metrics

As an opening remark, Ahmed et al., (2019) outline a sustainability framework tool for evaluating national dietary guidelines. Whilst it does not identify specific indicators, it summarises a range of themes that could inform key performance indicators (KPIs) applicable to community-based diet interventions. These are listed in Table 2 and apply broadly across the 9 indicators described above that form the core of this review.

Table 2. Guidelines for the assessment of sustainable diets (Ahmed et al., (2019)

Theme	**Description**
Ecological Dimension	
Production quality:	The dietary guidelines support production systems that cultivate for nutritional quality (crop quality)
Adequate production:	The dietary guidelines promote adequate food production and agricultural productivity, such as incentives for production.
Biodiversity, agrobiodiversity, and ecosystem services:	The dietary guidelines support conservation and maintenance of biodiversity and agrobiodiversity as well as associated ecosystem services
Sustainable agriculture:	The dietary guidelines support sustainable agricultural practices and sustainable intensification that limit pesticide, herbicide and fertilizer use
Local and seasonal foods:	The dietary guidelines support the procurement of foods that are in season and are local
Soil, land, and water conservation and protection:	The dietary guidelines support the procurement of food in ways that prevent contamination of soil, land, and water resources, such as protecting watersheds from pollutants.
Low GHGE and climate resilience:	The dietary guidelines support production methods with relatively low GHG emissions; designing and managing for agricultural systems for climate change/climate resilience.
Economic Dimension	
Distribution, supply chains, and transport:	The dietary guidelines take into account food distribution, supply chains, and transport, such as direct sales between producers and consumers.
Economic aspects of food security:	The dietary guidelines recognize the importance of having healthy and recommended foods being affordable to overcome economic barriers of access to safe, nutritious, and desirable foods.
Food loss and waste:	The dietary guidelines recommend reducing food waste across the food system from farm through fork.
Food packaging:	The dietary guidelines promote reduced food packaging and recycling.
Food system livelihoods:	The dietary guidelines promote livelihoods to support stakeholders in the food system from on farm and throughout food value chains.
Farmers' markets and local food systems:	The dietary guidelines recognize the importance of local food systems including farmers' markets, community supported agriculture (CSA), food cooperatives, and food hubs
Food storage and preparation:	The dietary guidelines make recommendations to avoid resource-intensive food storage of cold chain items and high-energy preparation, such as the use of a microwave.
Food advertising:	The dietary guidelines recognize the role of food advertising and marketing on food choices.

Human Health Dimension	
Dietary diversity	The dietary guidelines promote dietary diversity to reduce risk of nutrient deficiencies
Regular exercise and physical activity	The dietary guidelines promote physical activity and movement away from sedentary lifestyles
Food safety	The dietary guidelines promote food safety to prevent foodborne illness, contamination, negative health influence of agriculture and diseases linked to chemicals and pesticide use
Energy limitation	The dietary guidelines promote the limitation of energy/calorie consumption and reduce portion sizes to prevent overweight, obesity, and diet-related non-communicable diseases
Ultra-processed food limitation	The dietary guidelines promote the limitation of ultra-processed foods and food high in added sugars
Plant-based diet and nutrient-dense foods	The dietary guidelines promote plant-based diets of nutrient dense foods, such as fruits, vegetables, and legumes to reduce risk of chronic disease while recommending less consumption of non-lean meat and processed meat including selecting of other non-meat choices of protein
Nutrition aspects of food security	The dietary guidelines promote nutrition aspects of food security including access to sufficient quantity and quality of nutritious foods to meet dietary needs
Holistic diets	The dietary guidelines promote a holistic dietary approach of healthy dietary patterns to meet personal, cultural, and traditional preferences that promote overall health
Sociocultural and political dimension	
Food consciousness:	The dietary guidelines recognises the role of food consciousness, consumer knowledge, and education in supporting healthy and sustainable food choices.
Consumer preferences:	The dietary guidelines recognize variation of food choice preferences and desirability of different foods on the basis of cultural history and other socio-cultural factors.
Equity issues:	The dietary guidelines support equity in the food system including on-farm, in market, trade, distribution, food service, and policy sectors.
Food sovereignty:	The dietary guidelines support food sovereignty, food rights, food justice, and empowerment.
Food knowledge and skills:	The dietary guidelines recognize variation of knowledge and skills as related to food cultivation, procurement, purchasing, planning, and preparation.
Food system and cultural values:	The dietary guidelines recognize variation of family, community, and traditional values in the food system.

Engel & Ruder (2020) systematically reviewed 19 interventions targeting intake of fruits/vegetables by Supplemental Nutrition Assistance Program (SNAP) participants. This incentivises participants using inducements to encourage FV purchases. Eleven of the 19 studies had enrolment processes to receive the incentive, and most studies provided the incentive in the form of a token, coupon, or voucher. The value of the incentives varied but was usually offered as a match. Incentives were typically redeemable only for fruit and vegetables, though 3 studies required a fruit or vegetable

purchase to trigger the delivery of an incentive for any SNAP-eligible food. Most studies were conducted at farmers' markets. Eighteen of the 19 studies reported a positive impact on participant purchase and/or consumption. A summary of diet change (fruit and vegetable intake) indicators appears in Tables 3 and 4.

Table 3. Assessment of fruit and vegetable purchases in nutrition incentive programmes (Engel & Ruder, 2020)

Author	**Fruit/vegetable assessment method**
Survey Assessment of FV Purchases	
Alaofè et al. (2017)	Frequency of farmer's market shopping, purchasing amount, and types of purchases were assessed by the questions: 1. "Because of Double-Up SNAP Pilot (DUSP) program rebates, is your family buying a larger amount of . . . ?" 2. "Because of DUSP program rebates, is your family eating a greater amount of . . . ?", and 3. "Because of DUSP program rebates, have you or your family tried any new or unfamiliar fruits or vegetables?"
Amaro and Roberts (2017)	Open-ended survey responses demonstrated that participants purchased FV at the farmers' market because the incentive program made it affordable for them to do so. Additionally, they were asked to indicate the degree to which they agreed or disagreed with "I can afford to buy fresh fruits and vegetables"
Bartlett et al. (2014)	Specific survey items not provided but questions sought to discern general food shopping patterns and food expenditures.
Bowling et al. (2016)	"How much of your family's weekly WIC/SNAP budget is spent on FVs?"
Dimitri et al. (2013)	Survey assessed questions covering five aspects: (1) frequency of shopping at farmers' markets and the number of years receiving incentives, (2) perception of how much incentives influenced the decision to shop at the farmers' market, (3) perception of the impact that shopping at the market with incentives had on fresh FV consumption, (4) importance of farmers' market characteristics on the decision to shop at that market, and (5) access to the market and use of the market for fresh FV
Lindsay et al. (2013)	"How much on average do you spend on fresh fruits and vegetables per week?"
Marcinkevage et al. (2019)	Perceptions of affordability, purchase of FV not previously tried.
Olsho et al. (2015)	Specific survey items not provided but questions sought to discern changes in farmers' market spending, including whether FV were purchased each visit.
Ratigan et al. (2017)	Perceptions of food purchasing behaviour and affordability of FV, weekly spending on FV (<$10, $10–19, $20–29, $30–39, ≥$40.)
Interviews or Focus Groups to Assess FV purchases	
Bartlett et al. (2014)	Experiences with the program, including financial impact on the household and changes in willingness to purchase FV.
Savoie-Roskos et al. (2017)	Cost and budgeting as barriers to FV purchases prior to the incentive program emerged as themes and participants noted that the program helped them overcome these barriers, citing greater spending flexibility and decreased anxiety over the cost of food.
Bartlett et al. (2014)	pilot participants, focusing on HIP-eligible purchases, the amount of incentives earned, and the percent of SNAP benefits spent on HIP-eligible purchases. Analysis of spending in different types of store, focusing on spending on targeted FV in supermarkets and superstores.
Sales Tracking to Assess FV Purchases	
Freedman et al. (2014)	Sales tracking using unique identifier for each participant; transaction data, including date of transaction, customer type (patient, staff, or community member), total cost, and payment type; comparing venue revenue trends from the previous year with those during the implementation period.

Lindsay et al. (2013)	Data were collected from vendors regarding total sales each day from incentive tokens as a percentage of total sales.
Marcinkevage et al. (2019)	Quarterly and yearly redemption rates, dollar amount spent on FV per incentive redeemed.
Olsho et al. (2015)	Comparison of average daily SNAP sales from farmers' markets accepting incentives with those not accepting incentives.
Ratigan et al. (2017)	Records of market attendance and frequency of visits to booths where participants received incentives
Rummo et al. (2019)	FV spending as a percentage of total spending from individual transactions at grocery stores that implemented programs and that did not implement programs
Steele-Adjognon et al. (2017)	Loyalty card scanner data was acquired to assess: "FV expenditure; fruit expenditure; vegetable expenditure; FV expenditure share; FV variety; and FV purchase decision. FV expenditure is the aggregate dollar amount spent during the month on all fresh FV."
Wetherill et al. (2017)	Differences in baseline sociodemographic, predisposing, enabling, and reinforcing factors related to FV attitudes and behaviours by incentive redemption.
Young et al. (2013)	Comparison of market SNAP sales from implementation period to those from previous years; incentive redemption rates.

Table 4. Assessment of fruit and vegetable consumption in nutrition incentive programs (Engel & Ruder, 2020)

Author	**Fruit/vegetable assessment method**
Alaofè et al. (2017)	FV consumption frequency measured using Behavioural Risk Factor Surveillance System FV module.
Bartlett et al. (2014)	24-h dietary recall interviews at multiple points in implementation period and followed up by focus groups, which included discussion of impact on FV consumption. Surveys on FV consumption
Bowling et al. (2016)	Survey questions including "On an average day, how many times do you have a vegetable to eat?" and "On an average day, how many times do you have a fruit to eat?"
Dimitri et al. (2015)	National Health and Nutrition Examination Survey food frequency questionnaire: Number of times vegetables were consumed in the last six months, daily and weekly serving of FV
Dimitri et al. (2013)	Specific survey items not provided, but assessed participant perception that fresh FV consumption increased or did not increase.
Durward et al. (2019)	FV consumption frequency measured using Behavioural Risk Factor Surveillance System FV module
Lindsay et al. (2013)	"On average, how many servings of fruits and/or vegetables do you usually eat each day?" and "In general, how healthy would you say your overall diet is?"
Marcinkevage et al. (2019)	Survey included questions related to participant perceived improvement in the consumption of healthy foods, including FV, and perceived health benefit prescriptions (trying new FV, eating more FV, increases in FV consumption by family members.)
Olsho et al. (2015)	New York City Community Health Survey: "total servings of fruits and vegetables eaten on the previous day" and "consumption today vs. consumption one year ago"; interviews included questions about the consumption of FV from farmers' markets
Pellegrino et al. (2018)	FV consumption frequency measured using Behavioural Risk Factor Surveillance System FV module
Ratigan et al. (2017)	Survey regarding number of servings of FV consumed daily, rank overall dietary quality (very healthy, healthy, average, unhealthy, very unhealthy.)
Savoie-Roskos et al. (2016)	FV consumption frequency measured using Behavioural Risk Factor Surveillance System FV module

Savoie-Roskos et al. (2017)	Interview: "How does your diet now compare to your diet before the study?"
Young et al. (2013)	"Since becoming a customer at this market, do you eat more, less, or the same amount of fruits and vegetables?"

Hendrie et al., (2017) Conducted a systematic review to identify intervention characteristics associated with increasing consumption of vegetables in children (22 studies). They found a range of outcome measurements; however, the common use of self-reported intake poses issues and was associated with higher variability, meaning that small changes were more difficult to detect. This could have biased the review towards studies that were able to measure intake in a more robust way – such as in childcare settings where intake was often supervised, weighed and then the amount consumed reported in grams. A summary of the included study diet outcome measures appears in Table 5.

Table 5. Description of studies included in the review that assess the impact of an intervention of vegetable intake in the home and community settings (Hendrie et al., 2017)

Study	**Intervention**	**Data time points; Comp; CG**	**Veg intake measure**
Annesi et al. 2009	Youth fit for life program included PA, behavioural skills training, health and nutrition education. Contact: 3 × 45 min sessions/week (20 min Cardio PA/session), 2 × 20 min/week strength training, 20 min × 1/week behavioural skills, health and nutrition info 5–7 min/session	TP: baseline, post-I Comp: not stated CG: none	FFQ (2 items): frequency/ week
Bayer et al. 2009	'TigerKids' behavioural intervention targeted at: PA games at kindergarten, F&V consumption and habit formation of ≥2 FV portions/day & drinking water. Information materials & day-to-day activities to teachers, phone hotline for teacher support, information for parents, internet platform with info for teachers & families & shared FV plates offered. Contact: ~5 h/week	TP: baseline, 3–9 m, 12–20 m Comp: not stated CG: usual care	FFQ: portions/ day converted to % high V consumer ≥2portions
Castro et al., 2013	Growing healthy kids program: weekly sessions in community garden (staff assisted with garden preparation, planting etc), 7-week cooking & nutrition workshop (information & resources for healthy food choices), social events for families and garden newsletter. Contact: Weekly	TP: Baseline, 1, 2 & 3 years comp: family gardening participation 45% weekly, 45% 2–3×/month, 7%1/month, 3% no attendance data. CG: none	Survey (parent report): V variety available at home; usual servings consumed day/weekday
Corsini et al. 2011	3 groups: EO, exposure + reward (E + R) & control. EO group required parent to present & ask child to taste small piece of target veg daily for 2 weeks. E + R group same as EO procedure + 14-day sticker reward chart for tasting the veg. Contact: short daily activity	TP: Baseline, post-I (2 & 4 weeks, & 3 months) Comp: 94% returned exposure diary. 86% offered target V on ≥ 10 occasions. 56% children achieved 10 taste exposures. CG: normal feeding behaviour	Target V: g consumed usual intake: FFQ f/day Variety: number V/ week

Davis, 2011	Cooking /nutrition education, gardening lessons & market garden visits + 60 min parent nutrition & gardening class Contact: 90 min/week	TP: Baseline, 1-week post-I Comp: parent component – 25% participation CG: abbreviated delayed intervention after post-testing of IG.	FFQ (41 items): servings/day (previous day)
De Bock, 2011	Nutrition intervention: education on different foods, preparing, cooking, shared meals, parent education (modelling & child nutrition needs), interactive play, active parent participation & peer interaction. FV & water offered every week to increase exposure. Contact: 2 hours/week × 15 nutrition sessions (10 children only, 5 parents only or parent & child)	TP: baseline, 6 & 12 months Comp: not stated CG: waiting list control arm (received the intervention 6 months later).	FFQ: portions/ day
Engels et al. 2005	Program employed social, cognitive, & behavioural strategies. Content included: dance, sport, fitness & nutrition activities, targeted handouts & poster-board display, & motivational talk by public figure. Participants required to record daily FV intake & step counts. Contact: 60-75 min sessions 4 days/week	TP: Pre & post-I Comp: not stated CG: no Control	FFQ: f/day (converted to 0–10 score)
Freedman & Nickell, 2010	'Snack Smart' workshops: nutrition education through videos, food prep, tastings, label reading, games, creating recipes, handouts, role modelling, goal setting, barriers, home activities, social support networks. Reinforcements used + recipe book & draw prize post-I. Contact: 6 h total; 3 × 90 min/week after-school nutrition workshops, 2 × 45 min weekend workshops	TP: Baseline, post-I, 3–4 months Comp: Not stated CG: children acted as own control	FFQ: f/d (converted to 0–3 score)
Gholami et al., 2015	Theory-guided instructional leaflet provided to mothers after baseline; included info on consequences of behaviour, WHO healthy eating recommendations, instructions on how to perform behaviour, dietary action planning and coping planning exercises. Contact: Education leaflet mailed out	TP: Baseline, 2 weeks, 3 months Comp: Not stated CG: not stated	Survey: Usual portions/day
Haire-Joshu et al., 2008	High 5 for Kids: tailored newsletter based on pretest interview, home visits & materials for parent & child. Intervention strategies targeted knowledge, parental modelling, feeding practices, FV availability. Contact: 4 × 60 min home visits + newsletters	TP: baseline, 7 months Comp: Program delivered to 78% intervention families, 84% completed post-test CG: standard program	FFQ (27 items): Servings/day
Horne et al., 2011	Modelling & rewards intervention: videos screened during intervention featuring animated characters modelling consumption of target food & being rewarded for eating them. Letters from characters read out to reinforce target food, previous days intake and rewards. Rewards given for eating varying amounts of target foods. Contact: not specified	TP: baseline 1, fruit intervention, baseline 2, Christmas break, baseline 3, veg intervention, baseline 4, 6 months follow-up. Comp: not stated CG: no control	Observational record: % consumed
Horton et al., 2013	Intervention topics included: family relations/communication/ parenting styles,	TP: Baseline, 4 months 6 months Comp: retention rates I: 88%, C:91% CG	Survey (2Q) Cups/day, Variety in last month (44 items)

	stress & eating, healthy eating & FV, social support. Also included DVD		
Latif et al., 2011	2 x I groups (dietary or PA based). Dietary I: 5 A Day Badge program - functional knowledge & skills, tastings, recipe booklet. PA I: Fit for Life (FFL) Badge program - sporting activities, 'drills' booklet. Internet component: BCTs - goal setting/ review/modelling and problem solving Contact: 9 × 55 min/week group sessions (30 min in-troop activities/25 min internet activities)	TP: Baseline, post-I, 6 months post-intervention Comp: not stated CG	FFQ: servings/ day
Martinez-Andrade et al., 2014	Intervention group: obesity awareness & prevention workshops. Topics: portion size, healthy eating, label reading, meal planning, PA & sun exposure. Techniques included motivational interviewing, reflexive listening skills, goal setting/review, barriers, activities (games, cooking). Contact: 2 h/week (90 min workshop, 30 min shared food).	TP: Baseline, 3 months, 6 months Comp: 40% compliance to educational sessions. 35% families did not complete 3 months FU. CG: Usual care	FFQ: Servings/ week
Namenek Brouwer & Benjamin Neelon 2013	'Watch Me Grow' garden based program: grow a crop/month, weekly class activities (reading, tasting, garden, classroom). Program included a gardener to assist & health educator for menu review. Contact: 4 activities/month (~1/week). Duration not stated.	Comp: not stated CG: delayed intervention	Observation record: servings/2 days
Schwinn et al. 2014	3 session web delivered program to develop & maintain healthy relationships, bodies & minds. Topics: communication, family meals, knowledge of drugs, setting rules, food shopping skills, preparing healthy dinners, coping skills. Contact: 3 × 25 min sessions	TP: Baseline, post-test, 5 months FU Comp: 35/36 in intervention completed all sessions CG: no intervention materials	FFQ (21 items): f/week
Slusser et al. 2013	Catch Kids Club: 32-lesson ASP teaching students nutrition & skills to make healthy dietary & PA choices. Intervention sites received staff training in nutrition, child development & PA routines, curriculum resources, mentoring & assistance visits, nutrition education manual, activity box, & snack prep activities. Contact: -	TP: Baseline (Sep), follow-up at the end of school yr (June). Comp: Not stated CG: No training or support provided	Survey: f (previous day)
Somerville et al. 2012	Weekly activities included FV snack preparation, blind tasting, apple stamping, produce Pictionary, & FV bingo. Children encouraged to prepare & consume FV snacks during session & at home. Contact: 1 h/week	TP: Baseline, post-Is Comp: Not stated CG: No Control	Observation: Servings eaten at snack time (FV combined) Survey (7 item): usual Servings/day
Tabak et al. 2012	Intervention: 4 tailored monthly newsletters & 2 motivational phone calls. Calls addressed V/food issues from baseline surveys, areas for improvement, encouraged parents to describe successes, use problem solving to overcome barriers, receive support & encouragement. Newsletters addressed: V availability, picky eating, family meals, role modelling, individual feedback, goal setting, recipes,	TP: baseline, post-I (~5 months) Comp: not stated CG: 4 children's books (non-health/nutrition related) (1/month)	FFQ: servings/ day

	tips, resources and goal tracking. Contact: 4 monthly newsletters & 2 calls		
Witt & Dunn 2012	Colour me Healthy: designed for 4–5 years old pre-schoolers & delivered by pre-school teachers, provides interactive learning & teacher toolkit (lesson guides, picture cards, posters, music CD, hand stamps, parent newsletters etc). Activities encourage discussion about FV, tasting experiences. Contact: 3 sessions/ week, 15-30 min each	TP: baseline, post-I, 3 months post-I Comp: attendance 14.2 ± 4.0/18 lessons; completed take-home activities 3.4 ± 2.4/6 CG: no treatment	Weighed record: % of 1 Cup serve consumed

Kelly et al., (2013) reviewed 14 diet change interventions targeted to college students, to clarify metrics and make suggestions for their use in research. As part of the review, the authors listed metrics that were used in the reviewed studies. College students represent a segment of the population who may be less likely to comply with study requirements due to a range of factors (e.g. age, time availability, interest) and so the metrics reviewed may be useful for research with vulnerable populations. Conversely, the independent way in which diet data was collected, along with higher-than-average literacy levels amongst college students, may also indicate that the kinds of diet metrics used may be less suitable. Overall, the typical approach was to combine different diet and wellbeing metrics, in which FFQ was the most used method. Table 6 summarises the diet metrics from each study.

Table 6. Diet metrics of studies of interventions targeting dietary habits of college students (Kelly et al., 2013)

Study	**Approach**	**Diet metric**
Werch et al (2008)	In-Person Approach	Items assessing intake of FV, carbohydrates, and fat for previous 30 days
Ha et al 2011	In-Person Approach	3-day food log
Hekler et al 2010	In-Person Approach	FFQ; rating of healthy eating
Ha et al 2009	In-Person Approach	3-day food log
Ha et al 2009	In-Person Approach	3-day food log
Schnoll and Zimmerman 2001	In-Person Approach	3-day food log, knowledge and self-efficacy
Clifford et al 2009	Online Approach	FFQ; knowledge, attitudes, and behaviours
Morris and Merrill 2004	Online Approach	Items assessing perceptions of the program's impact on eating habits
Franko et al 2008	Online Approach	FFQ, FV item, SC, knowledge, barriers/benefits, social support, encouragement, and self-efficacy
Poddar et al 2010	Online Approach	7-d food log, outcome expectations, self-efficacy, self-regulation, and social support
Richards et al 2006	Online Approach	FFQ, SC, pros and cons, and self-efficacy

Buscher et al 2001	Environmental/Point-of-Purchase Approach	Study 1: Daily food sales; Study 2: Intercept survey
Peterson et al 2010	Environmental/Point-of-Purchase Approach	FFQ
Freedman et al 2010	Environmental/Point-of-Purchase Approach	Food sales

McAuley et al., (2023) conducted a systematic review and meta-analysis of the effectiveness of diet quality indices in measuring a change in diet quality over time in which 34 studies were reviewed. The samples typically came from populations experiencing significant health problems, including psychological distress, which may suggest their suitability for the current review. As above, many studies combined diet metrics, whilst the most common method utilised was a variant of the FFQ. Table 7 summarises the study metrics.

Table 7. Diet metrics of studies of interventions targeting dietary habits of (McAuley et al., 2023)

Reference	**Diet quality index**	**Characteristics of participants**	**Dietary assessment method**
Kelly et al (2020	AHEI-2010[2]	Adults with stage 3– 4 CKD	Validated 120-item FFQ
Koutoukidis et al (2019	AHEI-2010	Adult endometrial cancer survivors within 3 y of diagnosis	3 x 24-h recall
Turner-McGrievy et al (2008	AHEI-2010	Adults with T2DM	3-d food record
O'Brien et al (2014)	ARFS[3]	Adults aged 18–60 y with a BMI of 25- 40 kg/m2	Validated 120-item AES FFQ
O'Reilly et al (2019)	ARFS	Women aged ≥ 18 y with a GDM diagnosis, 12 mo post partum	Validated 120-item DQESV2 FFQ
Rollo et al (2017)	ARFS	Males aged 18–65 y with a BMI of 25- 40 kg/m2 and at high risk for developing T2DM	Validated 120-item DQESV2 FFQ
Steinberg et al (2019)	DASH score[4]	Adults aged 21–65 y with a BMI of 30- 45 kg/m2 and at least 1 of the following: HTN, T2DM, or hyperlipidaemia	Validated 110-item Block FFQ
Hansel et al (2017)	DQI-I[5]	Adults aged 18–75 y with abdominal obesity and T2DM	3-d food record
Demark-Wahnefried et al (2006)	DQI-R[6]	Adults aged ≥ 65 y and within 18 mo of locoregionally staged breast or prostate cancer diagnosis	3-d food record

[2] Alternative Healthy Eating Index (AHEI-2010)
[3] Australian Recommended Food Score (ARFS)
[4] DASH adherence scores (DASH score
[5] Diet Quality Index–International (DQI-I)
[6] Diet Quality Index–Revised (DQI-R).

Sallit et al (2009)	HEI-1995[7]	Women aged ≥ 19 y who were concerned about weight and wanted to lose weight	3-d food record
Stolley et al (2009)	HEI-1995	African-American or Black women aged 30–65 y with a BMI of 30– 50 kg/m2	Validated 110-item Block FFQ
Manios et al (2007	HEI-2000	Postmenopausal women aged 55–65 y with no chronic health conditions	3 × 24-h recall
Dodd et al (2014)	HEI-2005	Women with a BMI of > 25 kg/m^2 and singleton pregnancy between 10 and 20 wk of gestation	Validated 126-item Harvard FFQ
Lin et al (2013)	HEI-2005	Adults aged ≥ 25 y with HTN	Validated 110-item Block FFQ
Petrogianni et al (2013)	HEI-2005	Adults aged 40–60 y with a BMI of < 35 kg/m^2, TC of 200–310 mg/dl, and no use of medication	3 × 24-h recall
Wiltheiss et al (2013)	HEI-2005	Women 1–6 mo postpartum with a BMI of > 25kg/m^2, and another child aged 2–5 y	2 × 24-h recall
Berkowitz et al (2019)	HEI-2010	Adults with T2DM who have reported food insecurity	1 × 24-h recall at baseline and 3 × 24-h recall at follow-up
Harnack et al (2016)	HEI-2010	Adults in a household that reports income ≤ 200% of the federal poverty level	3 × 24-h recall
LaRose et al (2019)		Adults aged 18–35 y with a BMI of 21–30 kg/m^2	Validated 110-item Block FFQ
Ptomey et al (2018)		Adults with a BMI of > 25 kg/m^2 who were living in a supported environment	3-d food record
Njike et al (2015)		Adults aged 25–75 y with a high risk of T2DM	1 × 24-h recall
Thomson et al (2018)		Women < 19 wk pregnant with singleton pregnancy	1 × 24-h recall
Wieland et al (2018)		Adults with at least 1 adolescent (10–18 y) in their household	1 × 24-h recall
Woodruff et al (2019)		Women aged 35–65 y with a BMI of 25–45 kg/m^2	2 × 24-h recall
Basu et al (2019)	HEI-2010 & AHEI-2010	Adults aged ≥ 21 y living in a household that reports income < 250% of the federal poverty level	4 × 24-h recalls over the month
Marra et al (2019)	HEI-2015	Males aged 40–70 y with a BMI of ≥ 30kg/m^2 and a diagnosis of at least 1 of the following: HTN, hyperlipidaemia, prediabetes, or T2DM	4-d food record

[7] Healthy Eating Index

Järvelä-Reijonen et al (2018)	IDQ[8]	Psychologically distressed adults aged 25–60 y with a BMI of 27–34.9 kg/m^2	48-h recall
Panunzio et al (2011)	MAI[9]	Healthy adults aged 51–59 y	7-d weighed food record
Estruch et al (2018)	MEDAS[10]	Men aged 55–80 y and women aged 60–80 y with T2DM or ≥ 3 CVD risk factors	MEDAS, validated 137-item FFQ
Livingstone et al (2016)	MEDAS	Adults aged ≥ 18 y	Validated 157-item FFQ
Mayr et al (2019)	MEDAS	Adults with CHD who had experienced at least 1 of the following: acute MI, angina pectoris, CABG, or PCI	7-d food diary, MEDAS
Parletta et al (2019)	MEDAS	Adults aged 18–65 y with self-reported depression	MEDAS, simple dietary questionnaire, 3-d food record
Stradling et al (2021)	MEDAS	Adults with stable, virologically suppressed HIV infection and LDL-C > 3 mmol/L	3-d weighed food record
Sayón-Orea et al (2019)	MEDAS	Men aged 55–75 y and women aged 60–75 y with a BMI of 27–40 kg/m^2 who met at least 3 criteria for metabolic syndrome	Validated 143-item FFQ

Lashkarbolouk et al., (2022) systematically reviewed 22 studies investigating the impact of COVID19 on the diets of diabetic patients. Metrics combined mainly quantitative diet indices, alongside food practice metrics, biomarkers and anthropometric measures. Table 8 displays the outcome metrics across the 22 included studies.

Table 8. Diet outcome metrics across reviewed studies (Lashkarboulok et al., 2022)

Reference	**Study population**	**Outcome metrics**
Khare & Jindal (2020)	Type 2 DM	FBS[11]/PPBS[12] number of meals/amount of meals/timings of meals
Sankar et al (2020)	Type 2 DM	HbA1C[13]/weight timing of meals/snacks/ vegetables/fruits/fast foods
Olickal et al (2020)	Type 2 DM	FBS/PPBS vegetables/fruits/drinking alcohol
Ghosh et al (2020)	Type 2 DM	Weight amount of meals/timing of meals/ cooking at home/takeout/grains/snacks/fruits/ vegetables/sweets/fast foods/protein products
Khader et al (2020)	Type 1/2 DM, GDM, and Other types	PPBS amount of meals
Khare & Jindal (2020)	Type 2 DM	HbA1C/FBS/PPBS/weight number of meals/amount of meals/timing of

[8] Index of Diet Quality (IDQ)
[9] Mediterranean Adequacy Index (MAI
[10] Mediterranean Diet Adherence Screener (MEDAS
[11] Fasting blood sugar (FBS)
[12] Postprandial blood sugar (PBBS)
[13] Haemoglobin A1C (HbA1C)

		meals
Ruiz-Roso et al (2020)	Type 2 DM	snacks/vegetables/fruits/ sweets/protein products/legumes
Caruso et al (2021)	Type 1 DM	PPBS number of meals/grains/vegetables/sweets
Capaldo et al (2020)	Type 1 DM	HbA1C/PPBS amount of meals/timing of meals/snacks
Grabia et al (2020)	Type 1/2 DM	weight number of meals/cooking at home/takeout/ grains/snacks/vegetables /fruits/sweets/protein products/fast foods
Munekawa et al (2020)	Type 2 DM	HbA1C/weight amount of meals/takeout/snacks
Kishimoto et al (2021)	Type 1/2 DM	HbA1C/BMI amount of meals/timing of meals/cooking at home/takeout/grains/snacks/vegetables/sweets/ drinking alcohol
Takahara et al (2022)	Type 1/2 DM	HbA1C amount of meals/snacks/eating out
Maruo et al (2022)	Type 1/ 2 DM	HbA1C/weight amount of meals/timing of meals/snacks/fruits/ grains/drinking alcohol
Tanaka et al (2021)	Type1/2 DM and Other types	HbA1C/weight eating out/ takeout/ snacks/ drinking alcohol
Sisman et al (2021)	Type1/2 DM	weight drinking alcohol/grains/snacks
Tiwari et al (2021)	Type2 DM	PPBS
Verma et al (2021)	Type 2 DM	FBS/PPBS fruits/vegetables/legumes/protein products
Vetrani et al (2021)	Type 1 DM	PPBS Protein products/ grains/ sweets/ drinking alcohol
Amataiti et al (2021)	Pregnant women with Type1/2 DM and GDM	number of meals/cooking at home/takeout/ eating out/grains/snacks/vegetables /fruits/ sweets/protein products/fast foods/legumes
Carvalhal et al (2021)	Type 1 DM	number of meals/amount of meals/cooking at home/takeout/vegetables/fruits/sweets/fast foods
Hansel et al (2021)	Type 1/2 DM	BMI snacks/vegetables/ fruits/drinking alcohol

Ciliska et al., (2000) systematically reviewed 44 community-based diet interventions (targeted to increasing fruit and vegetable consumption in adults and children). The most common diet metric was the FFQ (33 studies), followed by 24-hour recall (10 studies), other food receipts (6 studies), dietary history (3 studies), weighed food record (2 studies), and non-weighed food record (1 study). Clear information and assessment of the precise metrics used was not included in the review, but available information about metrics is summarised in Table 9.

Table 9. Diet outcome metrics across reviewed studies (Ciliska et al., 2000)

Study	Approach	Sample	Diet metrics
Del Tredici et al (1988)	Interventions with parents of young children	663 low-income mothers in California	Fruit and vegetable consumption
Cox et al (1996)	Interventions with parents of young children	150 low income females in Virginia	Collected 3 24-hour recalls at each measurement time
Koblinsky et al (1992)	Interventions with parents of young children	171 mothers from Head Start program	Fruit consumption
Havas et al (1998)	Interventions with parents of young children	3122 low-income women on program for Women, Infants and Children (WIC)	Fruit and vegetable consumption FFQ
Graves et al (1982)	Interventions with school children	Grade schools K-grade 6	Food consumption FFQ
Shannon et al (1982)	Interventions with school children		Food consumption FFQ
Shannon & Chen (1988)	Interventions with school children	Grade 3 students continued in grades 4 & 5	Food consumption FFQ Diet attitudes and knowledge
Perry et al (1998)	Interventions with school children	536 grade 4 students	24-hour recall-
Perry et al (1998)	Interventions with school children	1186 grade 3 students in 96 schools	24-hour recall of daily servings of fruits and vegetables
Cullen et al (1997)	Interventions with school children	22 Girl Scout troops 259 girls (grades 4 and 5)	24-hour recall
Nicklas et al (1998)	Interventions with school children	12 schools Grade 9 followed to Grade 12	Knowledge Food consumption FFQ
Campbell et al (1994)	Interventions with adults-nonwork site	394 adult patients from family practice offices	Daily intake of fruits and vegetables FFQ
Gorbach et al (1990) Henderson et al (1990)	Interventions with adults-nonwork site	Women 45-69 at risk for breast cancer	Food consumption FFQ
Brownson et al (1996)	Interventions with adults-nonwork site	People in six counties in Southern Missouri	Food consumption FFQ
Sorensen et al (1996) Glanz (1998)	Interventions with adults-worksite	108 worksites 28,000 workers	Food consumption FFQ
Hunt et al (1993)	Interventions with adults-worksite	13 companies 1762 workers	Food consumption FFQ

Thompson et al., (2015) produced a detailed narrative review of 4 diet metrics (24-hour recall; food record; FFQ; screener) and their relative merits. Whilst they acknowledge that self-report methods are prone to error and bias, better understanding of a given method can help improve the quality of data collected.

More generally, the *24-hour Dietary Recall method* (24HR) requires 20 to 60 minutes to complete alongside a trained professional, hence it may not be feasible for use with

vulnerable groups, though a shorter version might be. The method also typically requires multiple snapshots of diet intake over the previous 24 hours.

Food records, (i.e. food diaries) comprise a self-reported record of all foods and beverages over a specified period. This method requires less time than dietary recall methods (around 15 minutes per day) so would potentially be feasible for use with vulnerable groups. Though participants must complete the record methodically and self-reported data can be unreliable.

Food Frequency Questionnaires (FFQ) use a survey method to record frequency and portion size of food and beverage consumption over a specified period (e.g. 1 week). The FFQ method typically takes 30-60 minutes to complete.

Screeners comprise short screening records of people's diet, typically over the previous month or even up to a year in the form of a questionnaire asking about general dietary practices (e.g. "Do you generally butter your bread?"). These are advantageous in that they require less cognitive effort and accuracy of recall; they do not require the participant to estimate frequency or portion size; and are brief to complete (typically 1round 15 minutes).

Of relevance in the context of the present review is that the FFQ and screener were judged to be the least cognitively demanding methods, whilst the food record required least effort in terms of diet recall. A summary of the metrics and review criteria is provided in Table 10.

Table 10. Major self-report dietary assessment instruments (Thompson et al., 2015)

		24-Hour Recall (24HR)	Food Record (FR)	Food Frequency Questionnaire (FFQ)	Screener (SCR)
Study Design	Cross-sectional	X	X	X	X
	Retrospective			X	X
	Prospective	X	X	X	X
	Intervention	X		X	X
Scope of interest	Total diet	X	X	X	
	One or a few components			X	X
Captures contextual details regarding food preparation, timing of meals, location of meals, etc.	Yes	X	X		
	No			X	X
Time frame of interest	Short term	X	X		
	Long term			X	X
Can be used to query diet in distant past	Yes			X	X
	No	X	X		
Allows cross-cultural comparisons	Yes	X	X		
	No			X	X
Major type of measurement error	Random	X	X		
	Systematic			X	X
Potential for reactivity	High		X		
	Low	X		X	X
Time required to complete	<15 minutes				X
	>20 minutes	X	X	X	
Memory requirements	Specific	X			
	Generic			X	X
	Does not rely on memory		X		
Cognitive difficulty	High			X	X
	Low	X	X		

Vucic et al., (2009) reviewed diet measures suitable for assessing micronutrient intakes among vulnerable population groups. Preferred methods were *24 h recalls* and *a FFQ* which, compared with the weighed inventory, also yielded higher estimates of energy and nutrient intakes. Many of the methods used in low-income populations had not been subjected to evaluation and consequently may not demonstrate sensitivity and/or specificity when used for this population. While based on a single study, the authors suggest *four multiple-pass 24 h recalls* as the most appropriate method for the evaluation of nutritional adequacy in low-income households.

Simmet et al., (2017) reviewed 16 articles containing diet quality measures in interventions with community food banks (i.e. users typically have a long history of food insecurity and may be vulnerable to nutritional deficiencies). Whilst they did not

compare measures, Table 11 displays the types of measures and metrics used in interventions with such populations, which mainly comprise variants of FFQ and HDR.

Table 11. Characteristics of 15 articles reporting the dietary quality of food pantry users (Simmet et al., 2017)

Study	**Design**	**Dietary assessment method**
Martin and colleagues, 2013	RCT	FFQ (block screener)
Robaina and Martin, 2013	RCT	FFQ (block screener)
Miller, 2011	Cross-sectional	FFQ
Holben, 2012	Cross-sectional	"produce-intake" items of the CCHS[14]
O'Reilly and colleagues, 2012	Cross-sectional	24-HDR, multiple-pass approach
Castetbon and colleagues, 2011	Cross-sectional	FFQ
Duffy and colleagues, 2009	Cross-sectional	24-HDR[15]
Rush and colleagues, 2007	Cross-sectional	24-HDR
Tarasuk, 2001	Cross-sectional	3×24-HDR
Jacobs Starkey and Kuhnlein, 2000	Cross-sectional	4×24-HDR
Jacobs Starkey and colleagues, 1999	Cohort study	4×24-HDR
Tarasuk and Beaton, 1999	Cohort study	3×24-HDR
Bell and colleagues, 1998	Cross-sectional	24-HDR
Starkey and colleagues, 1998	Cross-sectional	4×24-HDR
Lenhart and Read, 1989	Cross-sectional	24-HDR

Franck et al., (2023) assessed 24-HDR measures amongst low-income populations. They recommend its use when collected as designed: *one-on-one by a trained professional*. Peer educators were asked to share their experience, They identified several challenges such as time, resources, and participant reluctance to complete the recall in a group setting.

Subasinghe et al., (2016) sought to assess the accuracy of a meal recall questionnaire, adapted for use with impoverished populations living in rural areas of India. They found that a culturally adapted meal recall questionnaire provides an accurate measure for assessment of the intake of energy, macronutrients and some micronutrients in rural Indian populations

In an older article, Johnson (2002) sought to identify the most used methods to estimate dietary intake, identify their strengths and weaknesses, and make recommendations for their use (specifically in the treatment of *overweight or obese patients*).

[14] CCHS=Canadian Community Health Survey
[15] 24-HDR=24 hour dietary recall

In reviewing *traditional dietary intake metrics* (relying on subjective report), *food records* (e.g. food diaries typically obtained over a period of 3 to 7 days) whilst still used have many weaknesses that limit its use in studies; particularly with the advent of biomarker metrics. Food records also require literate, motivated subjects and the method places a high burden on participants. The quality of the record has been found to decline in relation to the number of days recorded. The actual process of recording food intake can also lead patients to change their food-intake patterns.

FFQs provide estimates of dietary intake over time, and list specific foods measured by asking the subject if they eat them, how often, and how much. Subjective report can lead to significant inaccuracy.

The *24-hour recall* was designed to quantitatively assess food and nutrient intake and can be conducted in person or by telephone with comparable results. This method requires only short-term memory, and if the recall is unannounced, the diet is not changed. It is appropriate for use with low-income and low-literacy populations because the subjects do not need to read or write to complete the recall. Disadvantages of the 24-hour recall include the inability of a single day's intake to fully describe the usual diet. The success of the recall also depends on the memory, cooperation, and communication ability of the subject. Finally, a trained interviewer is typically needed.

Tucker et al., (2007) carried out an assessment of dietary intake metrics and made the following observations:

Whilst *weighed diet records* can theoretically provide the most accurate assessment of intake, they are usually not realistic in large population studies due to heavy respondent burden, likelihood of poor compliance, and the cost of data entry. Hence, they would be less suitable for the current intervention.

Multiple *24-hour dietary recalls* can provide excellent detail, allowing for diverse dietary practices, but they are costly and require multiple contacts with participants.
FFQs are the most cost-effective tool for assessing usual intake, particularly for micronutrients with high day-to-day variability. However, they have limitations for diverse populations and recent studies have questioned their ability to measure macronutrient intakes for assessing diet and disease relationships.

Tucker et al conclude that FFQs remain the most cost-effective tool for large population studies. However, their limitations must be fully appreciated. When

macronutrients are of key interest, consideration should be given to the use of multiple recalls. *Records* may be used only in educated and compliant populations, and that continued efforts to improve dietary assessment methodology must be investigated.

Ngo et al., (2009) systematically reviewed ICT (information and communication technology)-based diet methods in light of the difficulties and misreporting inherent in traditional methods. Four types of method were assessed: computerised assessments; personal digital assistants (PDAs); digital photography; and smart cards. Computerised assessments (frequency questionnaires, 24 h recalls, diet history assessments) were found to be potentially useful in use with populations with lower literacy, and younger age groups, but also created a barrier in terms of lack of familiarity with the technology.

Digital self-administered 24HR yielded comparable results as standard methods but needed supervision if used with children. Computer-assisted interviewer-administered recall results were similar to conventional recalls and reduced inter-interviewer variability. PDAs showed some advantages but did not reduce underreporting. Mobile phone meal photos did not improve PDA accuracy. Digital photography for assessing individual food intake in dining facilities was accurate for adults and children, although validity was slightly higher with direct visual observation. Smart cards in dining facilities were useful for measuring food choice but not total dietary intake.

The authors concluded that computerised assessments and PDA were promising and could improve dietary assessment quality in some vulnerable groups and decrease researcher workload. Table 12 summarises the dietary methods across studies.

Table 12. Characteristics of selected studies on dietary-intake assessment and ICT (Ngo et al., 2009)

Study	Sample characteristics	Methods	Results
FFQ self-admin			
Edwards et al. (2007)	Usability subset n 604 (32·8 % m, 67·2 % f; aged 18– . 69 years; 75 % aged 18–49 years; self-identified as American Indian or Alaska native; 27·8 % , high-school education)	Analysis based on baseline study data, auxiliary background data and short usability questionnaire (using five item Likert scale) after monitoring food intake, physical activity, medical history and other lifestyle data with ACASI.	96·0 % of participants found ACASI questionnaires enjoyable to use, 97·2 % reported ease of use and 82·6 % preferred ACASI for future questionnaires. 62 % indicated more directions were needed. 10·6 % reported to have difficulty using ACASI. Lower educational level and less frequent computer use in past year associated with usability difficulty.
Slattery et al. (2008)	Six thousand and six hundred and four study participants (self-identify as American Indian or Alaska native, 36·0 % men, 64 % women; aged 18– . 65 years; 60 % aged younger than 45 years; 22 % with less than a high school education, 6 % college graduates).	Completion of audio computer-assisted interview; anthropometric measurements, blood pressure and a finger stick blood draw.	Almost 100 % of participants had complete DHQ data. More difficulties seen with lower education and acculturation levels as well as younger men and the unemployed. Low underreporting based on reported energy intake, but 18 % reported suspect high non-alcoholic energy intake (.33 472 kJ (.8000 kcal) or 29 176 kJ (6500 kcal) for men and women, respectively). Average time to complete questionnaire was 36 min.
Vandelanotte et al. (2004)	Two hundred and twenty participants (20–60 years of age) 67 % university or college education.	Participants completed a computerised questionnaire about demographics, fat intake and psychosocial determinants, and received personal fat intake advice. An evaluation questionnaire was completed during and after the tailored program.	Participants rated the diagnostic tool positively. (Likert scales were 3·96 (SD 0·57) and 4·17 (SD 0·58)). No significant differences were found according to sex, education levels and computer literacy. Significant differences were found between age groups and stages of change.
24HR self-admin			
Vereecken et al. (2005)(	Study 1 136 pupils of two secondary schools (12–14 years of age). Study 2 101 pupils of two primary (11–12 years of age) and two secondary schools (12–14 years of age).	Study 1 Completed 1-d- EFR and the following day YANA-C (both under supervision). One week later, YANA-C was administered a second time. Study 2 Completed supervised YANA-C and 24 h dietary recall interview on the same day. A subsample completed a survey on PC experience, general attitude towards computers and their acceptability of YANA-C. A five-point scale was used.	Matches between YANA-C and standard methods ranged from 67 to 97 % (x ¼ 90 % EFR; 89 % with interview) k statistics 0·38–0·92 (x ¼ 0·73 and 0·70 EFR and interview, respectively). Mean Spearman correlations for YANA-C and EFR 0·62 and 0·67 for YANA-C and interview. In comparison with EFR, on average 56 % were classified into same tertile and 6 % into the opposite tertile, whereas 61 % were classified into the same tertile and 5 % into the opposite tertile with the interview.
Baranowski et al. (2002)	n 138 school children (mean	Comparisons between FIRSSt (not specified if supervised), school	FIRSSt v. observation: Accuracy: 46 % match, errors: 24 % intrusion, 30 % omission rates. 24HR

	age 9·6 years; 33·7 % EuroAmerican, 30·4 % African–American, 14·5 % Hispanic and 21·4 % other).	lunch observations and a dietitian-conducted multiple-pass 24HR. A six group design was used to test observation and sequencing affects, as well as hair samples. Questionnaire evaluating FIRSSt.	v. observation: 59, 17 and 24 %, respectively. FIRSSt v. 24-h recall: 60, 15 and 24 %, respectively. Obtaining a hair sample reduced the omission rate for FIRSSt v. 24HR and increased the match rate for 24HR v. observation. Children generally enjoyed using FIRSSt.
Zoellner et al. (2005)	Eighty low-income English- and Spanish-speaking participants (91 % female; ages 18–65; 28 % , high-school education).	Participants completed both an IMM recall (minimal guidance) and an interview-administered recall consecutively on the same day. Participants were asked to complete a brief opinion survey. A five-point Likert scale was used.	Mean of unadjusted correlation coefficients for IMM and 24HR was 0·6. (notable exceptions folate 0·29 and alcohol 0·99). 53 % of participants preferred IMM, 39 % preferred an interviewer and 8 % preferred a pencil/paper method. Mean time of completion: 12·5 min (IMM) v. 20 min for 24HR (completion þ analysis).
24HR interviewer-admin Slimani et al. (2000)	Thirty two thousand and sixty three subjects from ten countries participating in EPIC calibration study	Seventy interviewers in ten countries administered two-pass computer assisted 24HR. Differences in energy intakes across interviewers were compared, adjusting for potential confounders.	For men, no significant differences were found between interviewers in five out of seven countries and for women no significant differences in four out of eight countries. The difference in mean energy intake between centres in the same country was in general NS. The percentage of interviewers with a mean energy intake within (SD 10) % of the country mean energy intake was 98 % for men and 94 % for women.
Diet history interviewer-admin Landig et al. (1998)(	n 20 hospitalised patients (12 m, 8 w; mean age 65 years, range 47–74 years). Exclusion criteria: severe diseases, more than 2 d of fasting, mental confusion and special diets.	Comparison of actual intake (weighed daily amounts of food consumed) to data from two computerised interviewer-administered diet history methods. Intake of macronutrients and ten micronutrients evaluated and percentage difference calculated.	Mean daily intake of nutrients calculated by DH deviated from 234 % to þ20 % (mean SD ¼ 48·1) and from 235 % to þ15 % (mean SD ¼ 28·1 %) with EBIS. Nutrient estimates calculated from both methods tended to underestimate intakes, possibly due to the context of recalling hospital prepared foods.
Bakker et al. (2003)	n 436, mean age 32 (FTF). n 352, mean age 36 (CAFTF). n 82 subjects agreement analysis.	Data from cross check FTF interview at cohort mean age of 32 years compared to data collected with new cross check CAFTF tool at cohort mean age of 36 years, both referring to prior 4 week intake. Data compared from eighty-two subjects interviewed by FTF at 32 years and at 36 years by a different interviewer using CAFTF to test agreement	ANOVA CAFTF 0·012–3·829 and for FTF 1·422–11·583. The paired-sample differences, standard deviations and P-values showed some differences. Pearson's correlation coefficients 0·6–0·9. All intra-class coefficients in range of 0·6–0·9. k ranged from 0·4 to 0·8. Bland–Altman plots showed no relevant differences.
Beasley et al. (2005)	Thirty-nine adults (twenty-one women, eighteen men; thirty six white, three black, one Hispanic; mean age 53 years; mean BMI 28 kg/m2; mean years of education 16).	Three-day PDA-based food records were compared with 24HR and an observed, weighed and timed lunch. Sources of error were quantified by using calories as the unit of comparison.	No significant differences in daily totals for calories and macronutrients between PDA data and comparison measurements. Pearson's correlations for PDA and 24HR: 0·5–0·8; for PDA data and observed lunch: 0·4–0·8. The largest source of absolute error in caloric estimation was attributable to portion size estimation error (49 %)
Yon, 2006	Sixty-one white adults (fifty-six women, five men;	Part of 24 week in-person behavioural weight control programme. Provided with PDA	The prevalence of low-energy reporting observed in the present study (41 %) was

	mean age 48·2 years; mean BMI at baseline 32·2; 66 % with university degree).	using Calorie King's Handheld Diet Dietary software. Energy intakes from 7 d PDA food records were collected within the first month. Goldberg cut-off values were used to classify individual subjects as low energy, valid or overreported. Underreporting compared with prevalence reported in literature. Questionnaires exploring PDA use collected at baseline and 6 months.	consistent with underreporting prevalence reported in the literature (27–46 %).
Wang, 2006	Twenty-eight female university food and nutrition students (mean age 19·3 (SD0·5) years; mean body weight 53·3 (SD8·5) kg; mean BMI 21·4 (SD2·9)).	One-day WFR with subjects taking digital photos of all recorded foods, and photos sent to study dietitians by mobile phone card. An unannounced interview-administered 24HR was carried out the following day. Procedures were repeated after 6 months. Subjects completed a self-administered questionnaire regarding the three assessment methods.	Differences between the Wellnavie method and WFR not statistically significant for most of the thirty-three nutrients except Zn, Mn, vitamin E, SFA, PUFA and dietary fibre. Spearman correlation coefficients were stronger for 24HR v. WFR (mean of two periods measured ¼ 0·77) than for Wellnavie v. FR (mean ¼ 0·62). 57·1 % of subjects considered the Wellnavie method to be the least burdensome and the least time consuming, and 42·9 % stated they could continue for a month using Wellnavie. Yes Kikunaga, 2007(20) Validation of a new dietary assessment method, a PDA with camera and mobile phone card (Wellnavie) and evaluation of the relation between obesity and underreporting using Wellnavie. Seventy-five healthy volunteers (twenty-seven men, forty-eight women, forty-three nonobese and thirty-two obese; aged 30–67 years). Subjects took digital photos of their meals and had PDA display option to write in ingredients of dishes consumed. Data were sent to the dietitian by a mobile phone card. Data were compared to data obtained from WFR (five consecutive days). The association between obesity and underreporting using Wellnavie was compared with results from both WFR and a motion and time study.
Kikunaga, 2007	Seventy-five healthy volunteers (twenty-seven men, forty-eight women, forty-three nonobese and thirty-two obese; aged 30–67 years)	Subjects took digital photos of their meals and had PDA display option to write in ingredients of dishes consumed. Data were sent to the dietitian by a mobile phone card. Data were compared to data obtained from WFR (five consecutive days). The association between obesity and underreporting using Wellnavie was compared with results from both WFR and a motion and time study.	The Wellnavie method gave significantly lower values for daily nutrient intakes in all subjects than those obtained by the WFR, except for some nutrients. Significant Spearman correlations (0·32–0·75) for daily nutrient intakes measured by Wellnavie and the WFR method in all subjects, except for some nutrients. Obesity in men was a factor of underreporting but not in women.
Williamson, 2003	Simulation of sixty meals consisting of ten different portion sizes from six different university cafeteria menus was	Food selections and plate waste, as estimated by digital photography and direct visual estimation, were compared with weighed foods. For each method, three observers independently estimated portion sizes as a percentage of a standard serving. These percentages were	Pearson correlations with actual weighed foods for total grams: 0·89– 0·97for both digital photography and direct visual method. Correlations for direct visual estimation (between 0·95 and 0·97) often significantly higher than those for digital photography (between 0·89 and 0·94). Both methods tended to yield small over- or underestimates. Intra-class correlation

	prepared and weighed	multiplied by the weight of the standard portion to yield estimated weights.	coefficients for digital photography were 0·94 for food selection, 0·80 for plate waste and 0·92 for food intake, confirming good agreement among the three observers.
Martin, 2006	Forty-three participants (twenty-three boys and twenty girls; mean age 11·7 years; all Anglo-American).	Digital photography measured children's food intake at school lunch cafeteria for five consecutive days. Two registered dietitians estimated food selection, plate waste and food intake based on digital photography data. Photographs taken of weighed reference portions of each food item available. Adiposity assessed with body impedance analysis and BMI expressed as percentile rank. Mood and self-esteem assessed with questionnaires.	High degree of agreement observed between dietitians' estimates. Intraclass correlation coefficients for kilocalories selected and plate waste were both 0·95 and 0·93 for total kilocalories, and 0·93, 0·89 and 0·94 for fat, Pro % and CHO, respectively. Assessment over 3 d provided reliable and representative measure of intake. A significant association between food intake and adiposity supported convergent validity. Non-significant correlations between food intake and depressed mood and self-esteem supported discriminant validity.
Lambert, 2005	Food choices of sixty-five boys (aged 7–11 years).	Smart cards electronically recorded all transactions at the cash desk. During two 5-d trials (November and June), food choices were directly observed and recorded (plate waste) by researchers for 265 trays from sixty-five children. The data obtained by both methods were compared. To test the relationship between foods chosen and actual amounts of food consumed, portion size of eighty foods was determined and variations in portion sizes and food wastage identified.	Out of 265 trays, eleven yielding an accuracy rating of 95·9 %, had a significant discrepancy between food choices recorded by the researchers v. smart card data. Prepared, processed food items showed low variation in portion size. Foods served by catering staff or diners had far greater variation. Some items produced far less wastage than others. Edible wastage correction factor needed for each food item in order to convert food choices into intake data.

Muller-Stierlin et al., (2021) assessed dietary assessment methods for use with participants with mental health problems (comparing *3-day photographic diet record*; *1-day written food diary*; and *1-day weighed food protocol*). Overall, the food diary was *most acceptable* to participants, followed by the photographic record.

The difference in estimated energy intake between the three assessment methods was not statistically significant, indicating similar accuracy, though there was considerable individual variability. *Under-reporting* of food intake was considerable across all methods but appeared *highest* in the photographic record. *Food diary* and *photographic record* were both found to be feasible and accepted methods for assessing dietary intake in populations with mental health issues.

Other methods have used visual methods as a way of recording diet data. Unlike traditional self-report methods, they can offer greater accuracy. Fontana et al., (2020) compared the use of *photographic food records* and *diet diaries*, two commonly used metrics to measure dietary intake, against a novel electronic sensor (measuring counts

of chews and swallows using wearable sensors and video analysis), for estimating energy intake.

In comparing the traditional methods, photographic food records offered superior precision to the diet diary method and, therefore, were deemed valuable for longitudinal studies with repeated measures of dietary intake. The electronic sensor also showed promise for the collection of longitudinal dietary intake data.

Ho et al., (2020) reviewed 13 studies utilising image-assisted or image-based dietary assessments (food images as the primary dietary record, which have emerged as key methods for evaluating habitual dietary intake) to assess energy intake and macronutrients, compared to biomarker-based and traditional methods (24-hour dietary recall and estimated/weighed food records).

With the exception of the biomarker method, no statistical difference was found between image based and traditional methods, suggesting that, like traditional methods, image-based methods can exhibit significant measurement errors.

Similarly, Höchsmann et al., (2020) commented that self-report methods (e.g., food records) are still frequently used to assess energy and nutrient intake despite the inaccuracy of these methods. Whilst methods assessing food intake via images of foods have overcome many of the limitations of traditional self-report (e.g. in cafeteria settings), digital photography has proven to be unobtrusive and accurate and is the method of choice for assessing food provision, plate waste, and food intake: image capture of food selection and plate waste via the user's smartphone can produce accurate energy intake estimates, though accuracy is not guaranteed). The review concluded that digital image methods are less burdensome but also potentially lower in accuracy, and that no current method is without limitations across all intervention settings.

With reference to combined assessments of health *and* environmental indicators of diet. Guo et al., (2022) conducted a systematic review of 33 interventions targeted to the combined assessment of food and diet. The precise diet metrics used were not provided in the review, though the broad dietary approach and health approach of each study is summarised in Table 13. The most common approach (n = 26) was to use parallel assessment by presenting the health and environmental outcomes separately and, in some cases, examine how they correlate in the analysis. Scaled assessment, where the health and environmental outcomes from dietary intake were assessed based on a common unit was used in seven studies. The common units applied were either based on an economic valuation where the health and environmental effects were translated into economic measures, expressed in disability-adjusted life years (DALYs) by including both health effects due to food consumption

and environmental health effects due to food production, or expressed in carbon dioxide equivalents by including both climate impact from food production and from the health care system through the diets contribution of dietary-related health effects. One study used an integrated assessment where the effects of diet change were measured by using a three-dimensional Sustainable Diet Index including sustainability aspects related to health and environmental outcomes, and monetary cost.

Table 13. Characteristics of combined health and environment intervention outcome methods and metrics (Guo et al., 2022)

Study	Diet approach	Dietary exposure (used for health assessment)
Aston et al (2012)	Dietary approach: Cohort divided into sub-groups of meat consumers and one vegetarian group. Modeling: The proportions of vegetarians in each sex doubled and the remainder of the population adopted the average dietary pattern of the fifth with lowest current consumption of meat.	Intake data: Food groups: RPM[16]
Scarborough et al (2012)	Purchase data: Reduction in meat and dairy replaced by fruits, vegetables and cereals; Reduction in cow and sheep meat replaced with pigs and poultry; Reduction of pigs and poultry replaced with fruit, vegetables and cereals.	Food groups: F&V [17] Nutrients and energy: total energy, fibre, total fat, MUFA[18], PUFA[19], SFA[20], TFA[21], dietary cholesterol, salt
Briggs et al (2013)	Purchase data: Taxation/subsidy approach: GHG emissions tax of £2.72/tCO2e/100 g product applied to all food groups with emissions greater than 0.41 kg CO2e/100 g, the mean level of emissions across all food groups	Food groups: F&V Nutrients and energy: total energy, fibre, total fat, MUFA, PUFA, SFA, TFA, dietary cholesterol, salt
Biesbroek et al. (2014)	Dietary approach: Substitution of 35 g/d of total meat intake by an equal food weight of potatoes, pasta-rice-couscous, vegetables, fruits-nuts-seeds, milk-based desserts, fish or cheese.	Intake data: Total self-reported diets: modelling a replacement of some of the total meat intake by an equal food weight of potatoes, pasta-rice-couscous, vegetables, fruits-nuts-seeds, milk-based desserts, fish or cheese.
Soret et al. (2014)	Dietary approach: Vegetarian diet; semi-vegetarian diet; non-vegetarian diet	Intake data: Total self-reported diets: comparing non-vegetarian diets with vegetarian and semi-vegetarian diets
Milner et al (2015)	Environmental approach: Optimized diet to meet the WHO nutritional recommendations without any GHG emission reduction target; Optimized diet to reduce dietary GHG emissions by 10%, 20%, 30%, 40%, 50% and 60% while meeting the WHO nutritional recommendations.	Intake data: Food groups: F&V, RPM
Briggs et al (2016)	Taxation/subsidy approach: A) GHG emissions tax of £2.86/tCO2e/100 g product on all products with emissions greater than the mean across all food groups (0.36 kg CO2e/100 g); B) As with scenario A but with subsidies on foods with	Purchase data: Food groups: F&V, alcohol Nutrients and energy: total energy, salt, fibre, cholesterol, total fat, SFA, PUFA, MUFA

[16] RPM = red and processed meat
[17] F&V = fruit and vegetables
[18] MUFA = mono-unsaturated fatty acids
[19] PUFA = poly-unsaturated fatty acids
[20] SFA = saturated fatty acids
[21] TFA = trans-fatty acids

	emissions lower than 0.36 kg CO2e/100 g such that the effect is revenue neutral; C) As with scenario A but with a 20% sales tax on SSBs; D) As with scenario B but with a 20% sales tax on SSBs.	
Irz et al (2016)	Recommendation approach: F&V +5%; Na −5%; SFA -5%; CO2e −5%; Red meat −5%; All meats −5%	Intake data: Food groups: F&V Nutrients and energy: total energy, fibre, total fat, MUFA, PUFA, SFA, dietary cholesterol, salt
Springmann et al (2016)	Dietary approach: Forecast year 2050: FAO guidelines; Healthy global diets; Vegetarian diet; Vegan diet	Supply data: Food groups: red meat, F&V
Stylianou et al (2016)	Dietary approach: One extra serving of fluid milk (increased caloric intake); One extra serving of fluid milk while subtracting equal caloric quantity from the overall diet; One extra serving of fluid milk while subtracting equal caloric quantity of SSBs.	Supply data: Food items and groups: milk, SSB[22]
Biesbroek et al (2016)	Dietary approach: WHO Healthy diet indicator, Diet approaches to stop hypertension index, Dutch healthy index 2015.	Intake data: Total self-reported diets: comparing diets with different adherence to dietary guidelines measured by three dietary indices
Farchi et al (2017)	Dietary approach: 40% of average daily consumption of beef meat and processed; 63% of average daily consumption of beef meat and processed meat; 80% of average daily consumption of beef meat and processed meat.	Intake data: Food groups: RPM
Hallström et al (2017)	Dietary approach: USDA recommendations; red meat 25 g/day (cooked); processed meat eliminated; red and processed meat eliminated. Meat replaced with beans and peas.	Supply data: Food groups: F&V, RPM, whole grains and refined grains, beans and peas
Milner et al., (2017)	Environmental approach: Optimizing diet to reduce blue water footprint, meet WHO guidelines for CHO, fats, free sugars, protein, sodium, F&V and no change in total dietary energy. Two different scenarios: 2025 scenario = population growth from 1,15 billion 2012 to 1,4 billion in 2025, water per person will be reduced by 18%. 2050 scenario = population reach 1,64 billion by 2050, water per person will be reduced by 30% compared to 2010.	Intake data: Food groups: red meat, F&V
Tainio et al (2017)	Dietary approach: Five scenarios where the intake of F&V increases with 1, 2, 3, 4 or 5 portions per day for everyone in the population and one scenario where the intake of F&V increase to five portions a day, for those individuals within the population consuming less than this at baseline.	Intake data: Food groups: F&V
Springmann et al (2018b)	Dietary approach: Replacing animal-source foods with plant-based foods by 25–100%; Improvement of calorie intake and weight; Four energy-balanced dietary patterns: flexitarian, pescatarian, vegetarian, vegan	Supply data: Food groups: red meat, F&V, nuts and seeds, fish, legumes
Springmann et al (2018c)	Taxation/subsidy approach: GHG taxation (23 dollar/tonne CO_2e) compared to no taxation data	Food groups: F&V, RPM

[22] SSB = sugar-sweetened beverage

Chen et al (2019)	Dietary approach: Healthy Swiss diet; Healthy global diet; vegetarian diet; vegan diet; pescatarian diet; flexitarian diet, protein-oriented diet; meat-oriented diet.	Supply data: Food groups: F&V, legumes, fish, nuts, seeds, red meat
Cobiac and Scarborough (2019)	Environmental approach: A diet that meets nutrition recommendations; a diet that meets nutrition recommendations but does not increase GHG emissions; a series of diets that meet nutrition recommendations and reduce GHG emissions in increasing 10% increments; a diet in which GHG emissions are minimized.	Intake data: Food groups: F&V, RPM, Nutrients: fibre, sodium, total fat, SFA, MUFA, PUFA, dietary cholesterol
Fresán et al (2019)	Dietary approach: Western dietary pattern; Mediterranean; Pro-vegetarian dietary pattern.	Intake data: Total self-reported diets: comparing three dietary patterns: the Mediterranean, the Western and the Pro-vegetarian
Irz et al	Recommendation approach: F&V +5%; Red meat −5%; All meats −5%; All animal products −5%; CO2e −5%.	Food groups: F&V Nutrients and energy: fibre, total fat, MUFA, PUFA, SFA, TFA, cholesterol, salt, total energy
Walker et al	Dietary approach: Cohort divided into sub-groups based on under- or overconsuming nutrients and foods.	Intake data: Food groups: F&V, whole grains, nuts and seeds, legumes, milk, RPM Nutrients: fibre, PUFA, omega-3 fatty acids, calcium, TFA
Broeks et al	Taxation/subsidy approach: 15% tax on meat; 30% tax on meat; 10% subsidy on F&V (over 30 years 2018–2048).	Intake data: Food groups: F&V, RPM
Damerau et al (2020)	Environmental approach: Linear optimization to maximize the micronutrient output of the national food supply under current and potential future regional land and freshwater constraints. Modelled potential food supplies have to meet or exceed today's national average caloric intakes.	Purchase data: Food groups: F&V, whole grains, SSB, nuts and legumes, RPM, alcohol Nutrients: TFA, long chain omega 3 fatty acids, PUFA, Na[23]
De Gavelle et al (2020)	Dietary approach: Pairing an increase in the portion size of a protein food with a reduction in the portion size of another protein food. Two scenarios: No constraint; Constrained by an increase in the plant: animal protein ratio.	Intake data: Food groups: F&V
Drew et al (2020)	Dietary approach: NZ Dietary Guidelines; once weekly plant-based meal; Beef and lamb replaced with poultry and pork; meat exchanged for seafood, eggs, legumes, nuts, seeds (pescatarian); once daily plant-based meal; meat and seafood exchanged for eggs, legumes, nuts, seed (lacto-ovo vegetarian); beef and lamb replaced with legumes, nuts, and seeds; meat, seafood, eggs exchanged for legumes, nuts, seeds (lacto-vegetarian): meat, seafood, eggs, and dairy replaced with plant-based alternatives (vegan); waste-free vegan	Intake data: Food groups: F&V, RPM, SSB Nutrients: Na, PUFA
Ernstoff et al (2020)	Dietary approach: vegan; vegetarian; gluten free; diets among population with primary education, secondary education and tertiary education, respectively	Intake data: Food groups: F&V, nuts and seeds, whole grains, RPM, milk, alcohol, SSB Nutrients: omega-3 from seafood, calcium, fibre, PUFA, SFA, TFA, Na
Fresán et al (2020)	Dietary approach: Adherence to the Dietary Guidelines for Americans Index (DAGI)	Intake data: Total self-reported diets: assessing diets with different scores of the Sustainable Diet Index

[23] Na = sodium

		(SDI), which takes into account nutritional quality, environmental impacts and market price of diets
Fresán et al (2020b)	Environmental approach: Cohort divided into sub-groups based on GHG emissions, land use, water use or energy use, respectively	Intake data: Total self-reported diets: comparing diets with different levels of environmental impact
González et al. (2020)	Environmental approach: Cohort divided into sub-groups based on GHG emissions, land use, water use or energy use, respectively	Intake data: Total self-reported diets: comparing diets with different daily dietary GHG emissions
Kesse-Guyot et al. (2020)	Dietary approach: French FBDG 2001; French FBDG 2017	Intake data: Food groups: F&V Nutrients and energy: fibre, total fat, MUFA, PUFA, SFA, cholesterol, salt, total energy
Scheelbeek et al. (2020)	Dietary approach: Adherence to the Eat Well Guide	Intake data: Total self-reported diets: comparing diets with different adherence to the UK national dietary recommendations the Eat Well Guide (EWG) Food and nutrient groups specified in the EWG were considered: F&V, oily fish, other fish, RPM, total fibre, total salt, free sugars, SFA, total fat
Springmann et al. (2020)	Dietary approach: 85 national FBDGs, WHO global recommendations, EAT Lancet. Comparison on national and global level (if the national FBDG were implemented globally).	Supply data: Food groups: RPM, F&V, nuts and seeds, whole grains, fish, legumes

Similar to Guo et al., (2022), Webb et al., (2023) reviewed 42 dietary interventions in relation to at least two of the following four thematic pillars: (i) planetary health, including, climate change, environmental quality, and natural resource impacts, (ii) human health and disease, (iii) economic outcomes, including diet cost/affordability, and (iv) social outcomes, e.g., wages, working conditions, and culturally relevant diets. They found that most dietary patterns used were statistically estimated or simulated rather than observed. An increasing number of studies targeted the cost/affordability of dietary scenarios in relation to optimised environmental and health outcomes. Only 6 publications incorporated social sustainability outcomes, representing an under-explored dimension of food system concerns.

They conclude that there are significant methodological challenges before fully integrating all four of the fundamental facets of sustainability where diets link human and planetary health. No articles included measures relevant to environmental, health, economic and social concerns simultaneously. As opposed to a continued focus on simple domain pairings (like diet and climate) using a small number of metrics that often only proxy outcomes of interest, standardised comparisons among studies will continue to be challenging, and specific recommendations about how to manage uncertainty as well as trade-offs will remain vague. The frequency of outcome measures across the 4 thematic pillars, are represented in Table 14.

Table 14. Frequency of outcome measures across thematic pillars (Webb et al., 2023).

Pillar	**Outcome measure category**	**Frequency (n/%)**
Health	Cancer	22 (23.2)
	Heart-related diseases	20 (21.1)
	Mortality, number of deaths averted, or years of life saved, non-specific disease	15 (15.8)
	Type 2 diabetes	12 (12.6)
	Stroke	10 (10.5)
	Disability-adjusted life year (DALY), non-specific disease	6 (6.3)
	Weight, overweight, or obesity	2 (2.1)
	Quality-adjusted life year (QALY) or quality of life (QOL), non-specific disease	2 (2.1)
	Composite health indicator	1 (1.1)
	Other	5 (5.3)
	Total	95 (100.0)
Environment	Climate change	44 (33.3)
	Land	20 (15.2)
	Water	18 (13.6)
	Toxicity	9 (6.8)
	Energy	7 (5.3)
	Eutrophication	7 (5.3)
	Air pollution	6 (4.5)
	Nitrogen or phosphorus	6 (4.5)
	Composite environmental indicator	5 (3.8)
	Acidification	4 (3.0)
	Biodiversity	2 (1.5)
	Other	4 (3.0)
	Total	132 (100.0)
Social	Food price/cost	26 (56.5)
	Economy-level cost	7 (15.2)
	Healthcare cost	6 (13.0)
	Productivity cost	3 (6.5)
	Employment	2 (4.3)
	Other	2 (4.3)
	Total	46 (100.0)

In summary, community diet interventions utilize a range of metrics to evaluate diet change among participants, encompassing dietary surveys and indices, nutrient analysis, and other behavioural assessments. By employing a multidimensional approach to assess changes in dietary intake, patterns, and quality, these interventions enable comprehensive evaluations of their impact on participants' dietary behaviours and nutritional status, thereby informing strategies for health promotion and disease prevention within community settings. To end this section, Table 15 displays various toolkits and resources for measuring diet and food intake.

Table 15. Resources and toolkits for diet and food intake measures and metrics

Source	Description	Link
Ai et al., (2024). Development of a Culinary Medicine Toolkit to Improve Implementation of Virtual Cooking Classes for Low-Income Adults with Type 2 Diabetes	Culinary medicine (CM) addresses diseases through nutrition and culinary education. To promote access to educational material for people with diabetes and engagement in virtual classes, we created a virtual culinary medicine toolkit (VCMT) sensitive to literacy levels and language preferences. The VCMT was developed to accompany existing virtual CM programs and help improve participant interaction and retention, offering educational materials for providers and participants.	Development of a Culinary Medicine Toolkit to Improve Implementation of Virtual Cooking Classes for Low-Income Adults with Type 2 Diabetes - PMC (nih.gov)
World Health Organisation, A toolkit on how to implement social prescribing:	This toolkit was created to help introduce social prescribing at the community level. It outlines the steps required to introduce a social prescribing scheme and includes sample materials which can be adapted to the local context. It can be used by implementing organizations, community healthcare and long-term care facilities, mental health and healthcare workers among others. Policy-makers and health and social welfare authorities may also find this resource useful for scaling up community interventions.	A toolkit on how to implement social prescribing (who.int)
Eden Project Communities	Community food projects are a great way to get people to learn about food, nutrition and cooking, whilst also making the most of local produce. Many of them also aim to improve the community and the environment. Community food projects are all about allowing local people to take control of where their food comes from and connecting them with each other and where they live. A food project gets everyone involved, brings communities together, and creates a sense of local pride.	Food, planet and community - Eden Project Communities
Food Research Council Community Eatwell Scheme	The Community Eatwell scheme is one of the few initiatives recommended in Henry Dimbleby's National Food Strategy independent review that is definitely due to go ahead. In this Policy Insight, Victoria Williams draws on her experience of piloting and assessing community food initiatives to examine the proposed Community Eatwell programme. This paper examines why Community Eatwell needs to be part of a larger 'jigsaw' of policy interventions, and must avoid duplicating or undermining existing food policy interventions.	The Community Eatwell scheme: Why it can only work as one piece of a jigsaw of interventions to tackle diet-related ill-health - Food Research Collaboration
Community Food Scotland Advice and Resources on how to set up and run your project for anyone involved in community food and health	Good practice and ideas: Looking for ideas on how to run a community food project? This section has good practice guides, toolkits and ideas for community cooking, community retailers, community catering and community growing projects, and some pointers on buying food supplies.	Advice and Resources on how to set up and run your project (communityfoodandhealth.org.uk)
Public Health England Strategies for Encouraging Healthier 'Out of Home' Food Provision A toolkit for local councils working with small food businesses.	This toolkit summarises the evidence base, types of interventions, and emerging local practice, to help those responsible within local councils (councillors, health and wellbeing boards, planners, public health and environmental health), to think about how working in a systems approach, they might bring together a coalition of partners to improve the food environment for children and families.	Strategies for Encouraging Healthier Out of Home Food Provision A toolkit for local councils (publishing.service.gov.uk)

Public Health England Healthier and more sustainable catering A toolkit for serving food to adults	This toolkit summarises government dietary recommendations for achieving a healthy diet as described in 'Healthier and More Sustainable Catering: Nutrition principles.'	Healthier and more sustainable catering: a toolkit for serving food to adults (publishing.service.gov.uk)
Our Healthy Year - Change4Life Toolkit:	Keep Reception and Year 6 pupils healthy this year and have fun with the new Change4Life Our Healthy Year activities! The Our Healthy Year toolkits are designed to build healthy habits in children during the school years in which they are weighed and measured as part of the National Child Measurement Programme. The activities will help schools to run a whole year of fun, healthy curriculum-linked activity and they'll also support parents who are looking for ideas to help live healthier lives. The toolkits include curriculum-linked activity ideas, a classroom poster, stickers and inspiration for whole-school activities. Supporting resources are available to download online, including take-home activities for children and parents.	Our Healthy Year - Change4Life Toolkit | Teaching Resources (tes.com)
Change4Life resource pack for early years settings:	Children are having nearly three times the maximum recommended amount of sugar they should have leading to tooth decay, obesity and type 2 diabetes. This newsletter will provide settings with ideas, resources and links to campaign resources from Change4Life, SUGAR SMART and Fizz Free February, to promote healthier lifestyle choices. A whole setting approach has been shown to be the most effective method to change not just knowledge but also attitudes and behaviour of children.	Change4Life resource pack for early years settings (govdelivery.com)
Change4Life Food Detectives Toolkit:	Developed by educational experts, the Food Detectives toolkit offers a wide range of fun and engaging activities that can be used within the classroom. The toolkit includes: Lesson plans – made up of starter activities, a main activity and plenary: Accompanying PowerPoint presentations: Fruit and Veg classroom activity: Odd One Out classroom activity: Undercover Investigation classroom activity: The 5 a Day Hunt playground activity: Sugar Scan Challenge classroom activity: Sugar Smart Trumps homework activity	Change4Life Food Detectives Toolkit - Curiosity Connections
Healthier and more sustainable catering A toolkit for serving food to older people in residential care:	This toolkit contains practical information and useful tips to help those working within residential care settings to buy, cook and serve healthier, more sustainable food	Healthier and more sustainable catering: a toolkit for serving food to older people in residential care (publishing.service.gov.uk)
Sustain Making the most of Healthy Start: A toolkit for local action:	The aim of this toolkit is to share what actions can be taken by local authorities, health professionals and the community sector to increase take up of the scheme locally. The toolkit covers: What is Healthy Start?: Working with health professionals: Promotion and campaigning: Increasing retailer participation and awareness: Mainstreaming into local welfare and advice services: Scotland's Best Start Foods:	Making the most of Healthy Start: A toolkit for local action | Sustain (sustainweb.org)
NICE, Community engagement: improving health and wellbeing:	This quality standard covers community engagement approaches to improve health and wellbeing and reduce health inequalities, and initiatives to change behaviours that harm people's health. This includes building on the	Overview | Community engagement: improving health and wellbeing | Quality standards | NICE

	strengths and capabilities of communities, helping them to identify their needs and working with them to design and deliver initiatives and improve equity.	
Prevention Research Center for Rural Health. Iowa City (IA): University of Iowa., Toolkit materials for the Healthy Options Program. Prevention Research Center for Rural Health. Iowa City (IA): University of Iowa:	This pilot tested the feasibility of program implementation and data collection methods, examined issues of program sustainability, and provided preliminary data on what customers want and what restaurant owners may be willing to change. Results were used to inform the design of a much larger statewide dissemination study involving rural restaurants. A Healthy Options toolkit was developed from this project for restaurants to use who are interested in making their own changes.	Healthy Options Toolkit | Prevention Research Center for Rural Health - The University of Iowa (uiowa.edu)
Love Food Hate Waste Toolkit:	In this toolkit you'll find the theory behind the development of our campaigns, insights, and a suite of engaging, ready-to-use assets which will help educate and motivate citizens around the world to reduce food waste by making the most of the food they buy. If we all do our bit, we can help encourage citizens to cut CO2 emissions while also saving them time and money.	Love Food Hate Waste Toolkit | WRAP
OECD Basic Toolkit:	Provides practitioners and policymakers with a step-by-step process for analyzing policy problems, building response strategies and developing interventions informed by behavioural and social sciences. Using insights from behavioural sciences can be a highly effective tool in influencing consumer behaviour and incentivizing increased demand for healthy diets.	Tools and Ethics for Applied Behavioural Insights: The BASIC Toolkit | en | OECD
UNEP, FAO, and UNDP Guide:	Annex 1 of the UNEP, FAO and UNDP Guide outlines a suite of tools and resources for monitoring, evaluation and learning in each step of the above multistakeholder collaboration process. Includes tools for fostering broad multistakeholder participation: Ensuring a good understanding of the food system: Nurturing inclusive and effective collaboration: Defining a compass and roadmap: Sustaining sustainability of collaboration	Rethinking_food_systems.pdf (unep.org)

3.0. Food practice change measures and metrics

3.1. Introduction

Beyond assessing changes in foods consumed and their impact on health, food practice methods and metrics are an important part of understanding the impact of community diet interventions. These cover a range of measures. *Food preparation and cooking* practices involve assessing changes in food preparation and cooking practices to understand how interventions influence participants' food-related skills and behaviours. Surveys or interviews may be used to collect data on participants' cooking frequency, culinary techniques, ingredient selection, and meal planning strategies. Additionally, observational methods such as kitchen audits or cooking demonstrations may provide qualitative insights into participants' cooking behaviours and the adoption of healthier cooking practices promoted by the intervention.

Food waste and sustainability practices involve evaluating changes in food waste and sustainability practices is increasingly recognised as an important aspect of community diet interventions aimed at promoting environmentally sustainable food choices. Metrics such as food waste audits, composting rates, and assessments of packaging waste reduction can provide quantitative measures of participants' efforts to minimise food waste and adopt more sustainable food consumption practices. Additionally, surveys or interviews may explore participants' attitudes, knowledge, and behaviours related to sustainable food sourcing, ethical food production, and environmental conservation practices.

Food security and access: methods are relevant for understanding the broader socio-economic impacts of community diet interventions on participants' ability to obtain and afford nutritious food. Metrics such as household food insecurity scales, food expenditure surveys, and assessments of food access barriers can provide insights into changes in participants' food security status and access to healthy food options within their communities. By addressing underlying socio-economic determinants of dietary behaviours, interventions can help improve food security and promote equitable access to nutritious foods particularly among vulnerable populations.

3.2. Food preparation interventions measures and metrics

With reference to community cooking workshops, in our review we found that typically evaluations were not reported or for those that did evaluate, simple observational methods or feedback were used to evaluate change in food practices. Examples

include The Fife Health and Social Care (CFHS) cooking skills evaluation study[24], The Forth Valley Sensory Centre cooking courses for people with visual sensory loss[25] and The NHS Grampian Confidence to Cook programme [26] . With reference to disadvantaged communities, Wrieden et al., (2007) evaluated the Cookwell programme in 8 socially disadvantaged communities across Scotland, using the following methods and metrics at 3 time points: a general interview questionnaire comprising closed questions (family sociodemographic characteristics; family mealtimes; frequency of eating out and buying 'takeaways'; and cooking information, e.g. what kind of meals are prepared); a cooking skills questionnaire comprising multiple choice questions to assess changes over time (family meals; confidence in cooking certain foods and techniques and following a recipe; kitchen equipment; factors influencing food choice and shopping behaviour; addition of salt; and frequency of eating fish, fruit and vegetables). This questionnaire was based on that used in previous work; food diaries were used to record estimated dietary intake for 7 days for all members of the family but completed by the participant; A food-frequency questionnaire (FFQ) was used as a cross-check for the 7-day food diaries and was completed when the food diaries were collected. The frequency of eating a total of 71 foods was recorded, 27 of those specifically concerning fruit and vegetables. The questionnaire was developed and refined from instruments used in national surveys such as the Scottish Health Survey and the National Diet and Nutrition Surveys.

Hasan et al., (2019) conducted a systematic review of 30 articles examining the effect of culinary interventions (cooking classes) on dietary intake and behavioural change. Whilst they do not provide a detailed description of outcome measures for each study, they found that studies included two types of outcome measure: *cardiometabolic* and *behavioural*.

Cardiometabolic outcome measures comprised:

— Glucose

[24] https://www.communityfoodandhealth.org.uk/community-based-activity/case-studies/fife-health-and-social-care-partnership-using-a-more-pragmatic-approach-to-cooking-skills/

[25] https://www.communityfoodandhealth.org.uk/community-based-activity/case-studies/cooking-skills-courses-for-people-who-are-visually-impaired-sensory-centre/

[26] https://www.communityfoodandhealth.org.uk/community-based-activity/case-studies/confidence-to-cook-training-the-trainers-improving-evaluation-skills-to-improve-cooking-skills-courses/

- haemoglobin A1c (HbA1c)
- Insulin
- homeostatic model assessment for insulin resistance (HOMA-IR)
- total cholesterol
- Triglycerides
- low density lipoprotein cholesterol (LDL-C)
- high density lipoprotein cholesterol (HDL-C)
- systolic blood pressure (SBP)
- diastolic blood pressure (DBP)

Anthropometrics measures comprised:

- body mass index (BMI)
- waist circumference
- body fat percentage.

Behavioural outcomes included:

- Attitudes
- self-efficacy
- healthy dietary intake.

In terms of the quality of outcome measures, the review found that culinary interventions were not associated with statistically significant changes in *BMI, SBP, DBP or LDL-C*, but were associated with *improved attitudes, self-efficacy and healthy dietary intake* in adults and children.

Farmer et al., (2018) systematically reviewed 11 community-based cooking interventions. Outcomes measures included confidence and self-esteem (2 studies). Haley and McKay (2004) used semi structured qualitative interviews with 12 mental health inpatients. Herbert et al. (2014) measured self-esteem (Rosenberg Global Self Esteem Scale) with Australian adults from communities experiencing lower socioeconomic status and high rates of obesity.

All the studies reviewed involved repeated participation in a cooking group, and all had other group activities including either a group meal, group clean up, or group discussion, thus allowing socialisation to occur. This was measured informally

Mood and Affect was measured in two studies. Hill et al. (2007) directly evaluated the impact of the cooking intervention on anxiety. Fitzsimmons and Buettner (2003) evaluated behavioural changes in affect following participation in their clinical trial

involving a cooking intervention for elderly females with dementia using the Cochrane-Mansfield Agitation Inventory and Passivity in Dementia Scale.

Wellbeing/quality of life was also measured (2 studies). Barak-Nahum et al. (2016) used the SF-12 Health-Related Quality of Life (HRQOL) questionnaire. Jyväkorpi et al. (2014) used questions that were previously validated in research to assess if a nutrition education and cooking class intervention led to changes in self-reported well-being.

Outcome metrics for reviewed studies comprised a range of pre-existing methods and measures including *wellbeing* (e.g. Health-Related Quality of Life (HRQOL, Positive and Negative Affect Schedule (PNAS) Short Form 12 (SF12)) and diet metrics (e.g. Intuitive Eating Scale (IES), 24-hour recall (RECALL-24)). Other interventions used their own pre- and post-programme questionnaires (e.g. perceived benefits and barriers to participation and to obtaining healthy food, participant focus groups assessing perceptions about community kitchens), whilst others utilised qualitative approaches (e.g. individual interviews with participants examining the processes that occurred during collective kitchen planning and cooking sessions and how the experience of participation influenced everyday lives, semi-structured interviews assessing participants' understanding of a cooking group's therapeutic goals, purpose, and structure, participant's perspectives on the baking group experience).

Other outcomes were also evaluated, including self-esteem through pre-existing quantitative scales (Rosenberg Global Self Esteem Scale) and qualitative methods gauging wider behavioural changes (semi-structured qualitative interviews explored impact of program on attitudes and behaviours, open-ended qualitative question assessed general feelings about the cooking group). Table 16 displays a summary of the included studies along with population characteristics and detailed outcome measures.

Table 16. Descriptive characteristics of culinary interventions and outcome measures (Farmer et al., 2018)

Study	Population	Assessment/Measures
Barak-Nahum (2016)	Adult cancer patients from Israeli community cancer center (intervention n = 96, 90 female; control n = 88, female 80)	Health-Related Quality of Life (HRQOL) Positive and Negative Affect Schedule (PNAS) Short Form 12 (SF12) Intuitive Eating Scale (IES) 24-hour recall (RECALL-24)
Crawford (1997)	Adult low-income participants in British Columbia community kitchen (n = 23 female	Pre- and post-program questionnaire administered by staff addressing perceived benefits and barriers to participation and to obtaining healthy food
Engler-Stringer (2007)	Community-based adults from 21 kitchens in three Canadian cities (n = 20, gender not provided)	Individual interviews with participants examining the processes that occurred during collective kitchen planning and cooking sessions and how the experience of participation influenced everyday lives

Fitzsimmons (2003)	Elderly females with dementia living in a residential facility (n = 12 females)	Cohen–Mansfield Agitation Inventory Passivity in Dementia Scale
Haley (2004	Adult mental health inpatients (n = 12, 2 female)	Semi-structured interviews assessing participants' understanding of cooking group's therapeutic goals, purpose, and structure; participant's perspectives on the baking group experience
Herbert (2014)	Community dwelling Australian adults (intervention n = 694, female 525; control n = 237 female 198)	Rosenberg Global Self Esteem Scale Researcher-developed 5-point Likert-type scale to assess cooking self-efficacy (based on previously validated tools) Semi-structured qualitative interviews explored impact of program on attitudes and behaviours
Hill (2007)	Hospitalized adult burn patients (n = 27, 9 female)	Investigator-designed 5-point Likert type questionnaire assessed: anxiety, burn preoccupation, peer interaction, and mobility/standing tolerance Open-ended qualitative question assessed general feelings about the cooking group
Jyväkorpi (2014)	Healthy elderly individuals from Helsinki, Finland (n = 54, 49 female)	Six validated questions assessing Psychological well-being (PWB)
Lee (2010	Participants from 11 community kitchens in Australia (n = 52, gender not provided)	Participant focus groups assessed participants' perceptions about community kitchens
Marquis (2001)	Community kitchen participants in British Columbia (n = 24, gender not provided)	Periodic survey and focus group with participants
Tarasuk (1999)	Low-income participants in 6 Canadian community kitchens (n = 14, 13 female)	Qualitative interviews to assess potential of program to affect income-related food insecurity

With further reference to community cooking interventions, Garcia et al., (2016) reviewed community Interventions to improve cooking skills and their effects on confidence and eating behaviour. Specific evaluation metrics were for each study were not provided in the review. A range of methods was used, mainly quantitative surveys, though some used interviews or a combination of the two. A summary of general outcome measures and outcomes appears in Table 17.

The review found that evaluation plans were often not incorporated within programme delivery, resulting in a lack of data on process and longer-term outcomes to support their continued use. Most evaluation tools used across studies were not properly validated, subjected to selection bias, highly reliant on self-report, or used varying definitions and measurements of eating/cooking behaviours. This made drawing conclusions on the effectiveness of cooking skill interventions to improve food preparation and health behaviours difficult.

Table 17. Summary of included studies (Garcia et al., 2016)

Study	Measurement	Outcome
Hutchinson et al. 2016	Self-administered questionnaires	At follow-up: significantly increases on F&V intake by 1.5 portions/day cooking confidence score increased by 1.7 (scale from 0–5) others: decreased consumption of snacks by less than one item a day.
Moreau et al. 2015	Self-administered questionnaire	At post-intervention: small significant ($p < 0.05$) increases in nutritional knowledge (87 to 89 %), confidence to eat healthily (77.5 to 80.5 %) and eating behaviours (82 to 85 %) compared to baseline. this included an increased proportion of people consuming 5 or more fruit and vegetables per day (41 to 57 %, $p < 0.05$)
Garcia et al. 2014	Self-administered questionnaire telephone-based interviews	At follow-up: increased cooking confidence in using basic ingredients (med: 7v6, $p = 0.033$), following simple recipes (med: 7v7, $p = 0.06$) and cooking new foods (med: 6v6, $p = 0.08$) increased intake of F &V to 'once a day'.
Abbot et al. 2012	Semi-structured in depth interviews	At post-intervention: increases in food knowledge, cooking techniques (i.e. reductions in oil/fat use) and improvements in food literacy.
Keller et al. 2004	Semi-structured interviews, self-administered short questionnaire	At post-intervention,: based on a 5 point Likert scale small non-significant increases in cooking confidence (pre 2.6 vs post 2.8), trying new foods (3.9 vs 4)
Beets et al., 2007	Self-administered questionnaire	Food preparation frequency remained unaltered, whereas significant improvements were reported in nutritional knowledge and perceived cooking ability ($p = 0.04$)

Other interventions have targeted other types of meal preparation. For example, there is a body of literature on improving the health of children's packed lunches at school. Mihrshahi et al., (2019) designed an intervention to increase fruit and vegetable consumption. Diet change was evaluated using a questionnaire assessing: Knowledge, attitudes and practices with respect to fruits, vegetables and *preparing and packing a healthy lunch box*. Where possible existing validated questions from the Australian National Nutrition and Physical Activity Survey,10 and questions from other evaluations of similar CCNSW programs,11 were used.

In addition to measuring the practice itself, the wider rules of domestic life and practice can also be significant in influencing what is eaten. Ashfield-Watt et al., (2007) conducted a diet and physical activity community intervention with children in which they utilised a 68-item Family Survey Form assessed by parent/caregiver report including fruit and vegetable and sugar-sweetened beverage consumption; FACET (Five-a-day Community Evaluation Tool). Parents/caregivers were also asked to indicate whether there were household rules related to television and computer use, bedtime, consumption of sugary foods and beverages, and snacking.

Other work has looked at targeting interventions towards dietary behaviours around prepared food (i.e. food purchased from cafes, shops, and restaurants). Gittelsohn et

al., (2012) reviewed 16 small food store interventions targeted to improving consumers' diets and broadly summarised a range of evaluation methods, comprising feasibility and process measures, store impact measures, consumer psychosocial measures, consumer behavioural measures. These are shown in Table 18.

For the *process* outcome measures, 15 trials collected some form of process data, 14 of which collected both qualitative and quantitative data (availability of promoted foods, presence of planned signage and other intervention materials, and store owner/manager engagement). Four trials also conducted store owner interviews to understand barriers to stocking.

For *store impact*, 15 trials assessed changes in availability of healthy foods; all used pre-post assessments. 10 assessments focused exclusively on perishable goods (produce, and, in 1 case, milk). 9 trials assessed impact on both food stocking and sales. 1 trial conducted weekly store-owner recall evaluations. 11 trials also examined impact on the store owners' and managers' psychosocial variables, including food-related knowledge, intentions, and outcome expectations for stocking healthy foods.

With reference to *consumer psychosocial* impact, 14 trials (8 of which used multiple methods) examined impact on consumer psychosocial characteristics. Of these, the most frequently assessed outcomes were consumer food-related knowledge (n = 11), intentions (n = 9), and self-efficacy (n = 8). Less frequently assessed were attitudes about stocking healthier foods (n = 3), perceived barriers to healthy food purchasing (n = 1), and outcome expectations (n = 1).

In terms of *consumer behavioural impact*, food purchasing patterns (e.g., frequency of purchase) were the most commonly assessed consumer behavioural change (n = 14). 13 trials used pre-post evaluations to assess changes in purchasing behaviours, 5 of which used a comparison group. 8 trials examined change in diet using pre-post assessments, 5 of which used a comparison group. A quantitative food frequency questionnaire served as the primary tool for assessments for those trials.
Four trials used surveys focused exclusively on intake of a subset of foods, such as produce.

Finally, for *consumer health outcomes*, only 4 trials examined health outcomes, all of which focused exclusively on body mass index (BMI) change measures.

Table 18. Evaluation strategies of small-store intervention trials (Gittelsohn et al., 2012)

Study	**Feasibility and process measures**	**Store impact measures**	**Consumer psychosocial measures**	**Consumer behavioural measures**
Apache Healthy Stores	In-depth interviews Process indicators (reach, dose, fidelity) Interventionist logs	Availability Sales Psychosocial (outcome expectations, intentions, self-efficacy to stock)	Knowledge Self-efficacy Intentions	Purchasing Preparation Diet
Baltimore Healthy Stores	In-depth interviews Direct observation – inventory Process indicators (reach, dose, fidelity) – logs	Availability Sales Psychosocial (outcome expectations, intentions, self-efficacy)	Knowledge Self-efficacy Intentions	Purchasing Preparation Diet
Have a Heart Paisley – Changing Lifestyle	Semi-structured interviews Direct observation – inventory Process indicators (reach, dose, fidelity)	Availability Sales Food quality Psychosocial (intentions – voucher use)	Knowledge Self-efficacy Intentions	Purchasing
Healthy Bodegas	In-depth interviews Direct observation – inventory Process indicators (reach, dose, fidelity)	Availability Sales Psychosocial (intentions to sell) Store layout Marketing (signage, shelf labels, coupons)	Knowledge Attitude	Purchasing
Live Well Colorado	In-depth interviews Direct observation – inventory	Availability Sales Marketing (signage, shelf labels, coupons)	None reported	Purchasing
Healthy Eating, Active Communities	In-depth interviews Focus group	Availability Sales	Knowledge	Purchasing Preparation

	Process indicators (reach, dose, fidelity)	Psychosocial (intentions to stock)		Diet Label reading

Papanek et al., (2023) make some important remarks regarding the assessment of community diet intervention outcomes.

— Large food retail establishments (e.g. grocery stores or supermarkets) sell products that can be classified as both healthy and unhealthy. However, grocery stores, supermarkets, and fresh fruit and vegetable markets are often categorised by researchers as healthy food retail. Conversely, convenience stores and fast-food restaurants are considered unhealthy food retail. Alternative metrics are available, such as he modified Retail Food Environment Index (mRFEI), which represents the relative density of healthy food retail establishments compared to the total number of food retail establishments in a given area (Mahendra et al., 2017). This measure was developed by the Centers for Disease Control and Prevention. More information about mRFEI can be found at https://www.cdc.gov/obesity/downloads/census-tract-level-state-maps-mrfei_TAG508.pdf.

— Food availability within the food store, home, restaurant, institutional, or worksite environment can be assessed using checklists, interviews and questionnaires, inventories, or market basket surveys (see Lytle & Sokol, 2017). The *Nutrition Environment Measures Survey (NEMS)* and its iterations, including *NEMS-Restaurant*, *NEMS-Store*, *NEMS-Corner Store*, *NEMS-Vending*, *NEMS-Grab and Go*, and *NEMS-Perceived*, have been developed by researchers at The University of Pennsylvania as an observational measure to assess community and consumer nutrition environments and the availability of healthy foods, including prices and quality. The nutrition environment refers to the availability of foods that are part of a healthy dietary pattern, whereas the community food environment includes all types of food. Tools, protocols, and trainings to use these measures can be found at https://nems-upenn.org/tools/.

— Determining needs through consumer and community input can be done through community needs assessments using focus groups, community forums, listening sessions, surveys, or interviews (*Sattanno et al., 2017*). The USDA's *Community Food Security Assessment Toolkit* offers a useful overview of how to assess the community nutrition environment, while NEMS addresses specific

food environments. To access the Community Food Security Assessment Toolkit, visit https://www.ers.usda.gov/publications/pub-details/?pubid=43179.

3.3. Food waste measures and metrics

A substantial research literature exists for interventions targeting the reduction of food waste, both domestically and in other spheres of the lifestyle. Reynolds et al., (2017) reviewed 17 consumption-stage food waste reduction interventions (household, education, hospitality). They concluded that in many interventions the evaluation evidence was scant and not robust. Methods, metrics, and timescales for measuring food waste are set out in Table 19.

Hospitality outlets typically used reported food waste weights (assumed to be gathered by waste audit). Households typically used self-reported via online survey of participants. Educational establishments often used mass flow of food from kitchen to plates to bin with waste weighed.

In terms of measures of food waste, these included weighed waste (plate and bin waste); self-reported level of perceived ability to prevent household food waste; picture measurement of plate waste (fraction left on plate); self-reported via interview, survey and focus group of participants; food waste audits; weight collected by smart bin; visual coding of plate waste (fraction left on plate); weighing of individual meals and leftovers for all meals; weighing of average meals (10 weights) and individual weighing of all leftovers; 2 days of meal measurement pre and post; weighing of plate waste.

The authors make the following observations: 5 interventions relied on self-reported (usually survey-based) measurements of food waste (a method that is relatively low-cost but suffers from substantial biases. 1 paper did not disclose any waste weights, while another 2 estimated food waste via visual analysis or pictures. The remaining 9 used weight-based waste measurement. It is a challenge to accurately quantify food waste prevented, largely due to the costs of waste measurement (especially in the home).

Due to a reliance on self-reporting, only the accuracy of the 3 plate-change/size-reduction interventions could be assessed with any certainty (as used by Kallbekken and Sælen, 2013, Wansink and van Ittersum, 2013, Williamson et al., 2016). These studies were not directly comparable as the methods of weight measurement and the

unit of measurement varied (i.e. per plate or aggregated total waste), and time intervals (study duration, number of observations, etc.) differ between each study.

Table 19. Summary of the 17 journal articles found with interventions that achieved a food waste reduction (Reynolds et al., 2017)

Study	**Waste measurement methods**	**Measurement time intervals**
Kallbekken and Sælen (2013)	Hotels reported food waste weights (assumed to be gathered by waste audit)	"Study duration: 2.5 months. The 52 hotel restaurants recorded and reported the amount of food waste daily over the whole period."
Young et al., (2017)	Self-reported via online survey of participants	Online self-report, One month before intervention, two weeks after intervention, and five months after intervention.
Schwartz et al (2015)	Measurement by mass flow of food from kitchen to plates to bin. Waste weighed.	Over 3 years, one measurement per year per school, collected each year in April, May,or June. To calculate average weight of serving, three servings of all food available weighed prior to lunch period, Pictures of food on trays taken before and after consumption. Trays collected and remaining food left on trays weighed and recorded.
Williamson et al. (2016)	Waste weighed (plate and bin waste) post experiments	S1: one of measurement event, food weighed prior, waste collected after and weighted. "S3A and B: Total weight of the buffet food was measured in the kitchen prior to being served" "S3C: All food weighed before service, any uneaten food was scraped into a waste bin, and weighed. 2 days of observations. Measure: average weights of waste per plate."
Schmidt (2016)	Self-reported level of perceived ability to prevent household food waste via survey of participants.	Baseline and post intervention measurements of self-reported food waste behaviours
Manomaivibool et al. (2016)	Picture measurement of plate waste (fraction left on plate).	Visual pictures food waste collected, 314 valid pictures taken at baseline, 148 post intervention
Dyen and Sirieix (2016)	Self-reported via interview of participants.	Self-reported waste reduction
Devaney and Davies (2016)	Food waste Audits	Week 1 and Week 5 food waste audit. Food waste was collected by householders for 3 days in advance of their next researcher visit, with participants asked to make a record of the type of food wasted and the reason for wasting it. The gathered food waste was then weighed by the researcher
Ganglbauer, E., Fitzpatrick, G. and Comber, R. (2013)	Self-reported via interview of participants.	Self-reported waste reduction
Whitehair, Shanklin and Brannon (2013)	Weighing of plate waste	6-week data collection period. Plate waste individually weighed.
Lim,Funk, Marcenaro, Regazzoni, Rauterberg, (2017)	Weight collected by smart bin. Self-reported via interview, survey, and focus group of participants.	Self-reported waste reduction
Jagau and Vyrastekova, (2017)	Visual coding of plate waste (fraction left on plate).	One week baseline, two weeks intervention. Measured % of food waste left on plate (not waste)
Lazell (2016)	None stated	Possible self-reported waste reduction
Martins, Rodrigues, Cunha, and Rocha (2016)	Weighing of individual meals and leftovers for all meals	Five-day baseline, with plates, food and plate waste weight collected for each child. Percentage of plate waste was calculated as the ratio of edible food discarded per edible food served to children. Weighed again in first week and then again after 3 months.

Cohen et al., (2014)	Weighing of average meals (10 weights) and individual weighing of all leftovers. 2 days of meal measurement pre (2011) and post (2012)	2 days of plate waste measurement per year, post meal trays collected, and each meal components waste measured separately.
Freedman & Brochado (2010)	Weighing of plate waste.	5-week study (1 week baseline), weight of food and waste measured for each bag.
Wansink, and van Ittersum (2013)	Weighing of plate waste. (S2)	Study 1 - self reported size of portion Study 2–4 restaurants, visual observation of 43 diners, with visual estimation of plate waste. Study 3–2 lines at one lunch event (209 individuals). Food weighed preservice and post service. No waste measurement.

In a study evaluating the effectiveness of a multi-component intervention at encouraging more sustainable food behaviours, Trewern et al., (2022) included a range of methods and metrics, as follows: *Survey metrics* (assessed participants' self-reported food behaviours, behavioural intentions and motivations, awareness of healthy, sustainable diets and barriers to adopting more sustainable behaviours (at all three timepoints assessed); as well as their perception on the effectiveness of intervention components (at T1 and T2)). *Focus groups* (conducted after the intervention-end survey and covering behaviour changes taking place during and after the intervention; how the intervention has supported behaviour change; and support needed to maintain behaviour changes in the future).

3.4. Food security measures and metrics

Other interventions have focused on *food security* and their outcome evaluation methods and metrics are summarised here.

Stluka et al., (2018) investigated methodologies for implementing multi-state community-based interventions in rural, high poverty communities in a US context. The outcome assessment methods are displayed in Table 20.

The authors noted a set of specific issues to be considered when researching this type of population. Included was the use of evidence-informed and some evidence-based tools when possible, and pre-testing the tools for feasibility, allowed for a comprehensive set of assessments to measure the effectiveness of the intervention as whole.

Table 20. Outcome assessment methods (Stluka et al., 2018)

Level	Method	Pre	Mid	Post	Subjects	Details
Community	Community stakeholders survey	X	X	X	Project staff	A 23-question Community Stakeholders Survey assessed community stakeholder perceptions in participating communities. This survey collected demographic information, perceptions of food security in the community, past experience with FPCs or similar organizations and feedback on the Voices for Food: Food Council Guide, and experience with the community coach.
	Food council implementation tracking form	X	X	X	Community Champion	A three-part Food Council Implementation Tracking Form tracked changes occurring in the FPC including: activities and accomplishments. Additionally, FPCs will provide key documents developed during the intervention, including meeting agendas, meeting minutes, press releases, organizational charts, mission/vision statements and strategic plans to the research team.
	Training tracking form	Ongoing			Pantry Director Community Champion	A 5-question Training Tracking Form tracked the number of trainings completed from the Voices for Food: Food Pantry Toolkit, training topics, numbers of attendees, curriculum used, who was in attendance (e.g. FPC members, food pantry clients, pantry staff, etc.), and the use of resources from the Voices for Food: Food Pantry Toolkit. Throughout the intervention, project staff documented the nature of Extension coaching assistance provided to the intervention food pantries
Food Pantry organisation level	Food Pantry Director Survey	X	X	X	Project staff	The 42-question Food Pantry Director Survey collected key information about the food pantry director and the food pantry including: demographic information, perceptions on community food security, and information about the food pantry
	Food Pantry Staff/Volunteer Survey	X	X	X	Project staff	A 34-question Food Pantry Staff/Volunteer Survey collected key information about food pantry staff/volunteers and the food pantry including: demographic information, community perceptions on food security, perceptions of their abilities to interact with clients, and information about the food pantry.
	Food Pantry Inventory Log	X	X	X	Project staff	One Food Pantry Inventory Log was maintained in a Microsoft Access database per state for all pantries to document the type and amounts of foods in stock at each food pantry site. Food pantry inventory data was collected on a date when the director indicated inventory will be relatively high (e.g. soon after food comes in from the food bank). The logs will be assigned United States Department of Agriculture [USDA] food codes in Food and Nutrient Database for Dietary Studies 5.0 that can be used to determine healthfulness of available food
	Food Pantry MyChoice Observation Tool	X	X	X	Project staff	A 15-question Food Pantry MyChoice Observation Tool, was completed by project staff, documented the extent to which key components of the MyChoice food pantry model were physically in

						place at the pantry and part of the food, food display, and distribution process.
Food Pantry Client Level	Food Pantry Client Survey	X	X	X	Project staff	A 54-question Food Pantry Client Survey collected information from pantry clients including: demographic information, household information, and participation in food assistant programs such as Supplemental Nutrition Assistance Program [SNAP], household food security, where food is purchased, experience at the food pantry, perception of pantry food selection, and perception of food-related community activities. The United States Household Food Security Survey Module [25, 26] is embedded into the Food Pantry Client Survey and will assess food security in pantry clients. Individuals will be classified as very low food secure, low food secure, marginal food secure and high food secure
	ASA24® Dietary Recall	X	X	X	Project staff	Dietary intake data (24-h recalls) were collected using the Automated Self-Administered 24-h (ASA24®) Dietary Assessment Tool, version 2014 and 2016, developed by the National Cancer Institute, Bethesda, MD [27]. The ASA24® was completed three times within the same week, on two weekdays and one weekend day. The first ASA24® was scheduled to be completed in-person with project staff on the day of the pantry visit. The second and third ASA24® recalls were self-completed or completed with project staff by telephone interview. The ASA24® allows for calculation of the Healthy Eating Index score, which is a measure of diet quality
	Participant Food Box Content Log	X	X	X	Project staff	One Pantry Food Box/Food Bag Log was maintained in Microsoft Access per state for all pantries, which detailed all food items the pantry clients receive during that pantry visit. Participant Food Box Content Logs were collected on the day of data collection in the pantry. The logs will be assigned USDA food codes that can be used to determine healthfulness of the foods that clients chose or were given at the pantry

Boyle & Power (2021) conducted a rapid review of proxy food security metrics in a UK-context to better understand the nature and scale of insecure food access. They concluded that proxy measures were unable to robustly assess the prevalence of food insecurity in the UK and provided a detailed critique of food security indicators. Metrics reviewed and critiqued, along with the main points were as follows (see Table 21):

Table 21. Summary of proxy indicators of food insecurity (Boyle & Power, 2021)

Food bank use.	In the absence of any direct measure of food insecurity in the UK there has been reliance on estimates of food bank usage, predominantly Trussell Trust food banks, to monitor the changing prevalence of food insecurity over time. The experience of food bank users can provide an important insight into some of the drivers, and therefore potential proxy indicators, of food insecurity. Food bank data is also uniquely useful as it has been reported longitudinally since food bank networks and usage started to increase circa 2005. Despite issues with the granularity of food bank statistics - e.g. identifying unique users - the data certainly suggests that the prevalence of food insecurity in the UK has increased significantly since 2005. However, food bank data can give only an incomplete measure of the prevalence of food insecurity. Measurement scales of food insecurity commonly differentiate between the severities of food insecurity faced. Worry over capacity to reliably obtain food and compromising on the quality of food consumed are associated with profound negative effects on mental and physical health10–12. It is essential that the number of individuals and households experiencing this mild to moderate level of food insecurity are accounted for in any measure of food insecurity prevalence. It is also evident that the majority of those in need may not access food bank provision23 and will therefore remain unacknowledged
Economic markers:	Macroeconomic markers are likely to blunt a measure to give any granular insight into the potential indicators or prevalence of food insecurity, since general economic trends may obscure the micro economic factors that may impact specific sections of the population. However, a wider perspective on the general economic landscape since 2005 serves as a useful background against which to discuss more detailed and specific proxy markers associated with food insecurity risk. Since 2005, the UK economy has been characterised by relatively low levels of economic growth. Can wider economic indicators be used to approximate the potential prevalence of food insecurity across the full experiential scale of severity? Poverty and associated economic markers can at least be considered indicative of a landscape in which there is an increased risk of food insecurity for many in a population. The Joseph Rowntree Foundation considers trends in poverty to be driven primarily by four factors: earnings, employment rate, housing costs, and benefits.
Household income.	The capacity to afford sufficient and appropriate food to sustain an active and healthy life is intrinsically linked to household income. Median income represents the level of household income above 50% of the UK population as a whole, giving an indication of average living standards of a population. Income is measured at the household level after the deduction of taxes and addition of state benefits and tax credits. Income is then 'equivalised' to rescale the value to account for different needs of households of different sizes and compositions. However, It is important to further interrogate data on median average income by demographic variables to ascertain if specific sections of the UK population have experienced comparable income profiles over time. Figure 4 also shows the median income for those aged below and above 60 years. This age disparity in average income growth corresponds to demographic food bank usage data that shows the greatest risk of being referred to food banks in those aged 25–54, with those of pension age (65+ years) comprising a minority of referrals (2%)19. This is further supported by data from the FRS food insecurity module that reported 3% of 64–74 year olds and 1% of those 74 years and above lived in food insecure households in 2019–20; compared to a range of 8–15% of those in younger age groups2 . However, the reported weekly equivalised household income AHC of Trussell Trust food bank users in 2018 was in the region of £5019. It is, thus, evident, that there is considerable variability in income around the median household income. Examination of incomes along the distribution will provide a clearer indication of the relative risk of having insufficient income to afford an adequate diet.
Measures of income-related poverty	Measures of poverty are commonly based upon the determination of income available to a household. The UK government measures poverty in relation to median household income. A distinction is made between the 'absolute' poverty rate, which compares household income to a median income level fixed in time (a base median income year of 2010–11 is used for the Department of Work and Pension's [DWP] Households Below Average Income [HBAI] statistics), and 'relative' poverty rate which compares household income to the median household income

	in the same year. A threshold of 60% below the comparison median household income value is adopted to characterise households falling into absolute and relative poverty. HBAI statistics assume all individuals in the household benefit equally from the combined household income and this is net of taxes and benefits and equivalised based on household size and composition.
In-work poverty	Having a job doesn't necessarily secure an adequate standard of living or protect households from poverty and food insecurity. Despite rising employment rates prior to the pandemic and the introduction of the National Living Wage, 58% of working households – households with at least one adult in paid employment – were living below the UK relative poverty line in 2017/18; compared to 37% of working households in 1994/9529. This heightened proportion of in poverty working households is largely reflective of changes in the labour market. Reduced household worklessness has increased the number of typically low-earning households in work (e.g. lone parents) which has changed the composition of working households. Improvements in the living standards of pensioners and workless households has also pushed up the relative poverty line. One would expect the prevalence or risk of food insecurity to fall as UK employment rates have increased. However, in-work poverty and a growing number of, particularly young, adults working in precarious employment has risen since the recession. Significant changes in housing tenure and housing costs have also disproportionately affected low income households, and younger adults in particular.
Changes in social security	Changes to the UK social security system have clear implications for households most vulnerable to experiencing food insecurity since a higher proportion of income in poorer households is derived from social security. Uprating of benefits restarted in April 2020 with benefits and tax credits linked to inflation rising by 1.7%. In response to the COVID-19 pandemic, UC standard allowances and the Working Tax Credit basic element have also been increased by £20 a week until September 2021. Even with such temporary increases to benefits during the pandemic, out-of-work households are in receipt of less support in 2020 than in 2011 – 10% lower on average and 12% lower in workless households with children than it would have been in 2011 without any policy changes in the interim
Benefit sanctions and conditionality	During the recent period of austerity and welfare reform it is not only the net amount of state support households receive that has been the focus of much debate in relation to food insecurity, restrictions in eligibility, increased conditionality and changes to the way benefits are administered have also come to the fore19. In 2018, the Trussell Trust reported that benefits were the most common form of income in 86% of referrals, and two-thirds of households referred to food bank provision had experienced problems with the benefit system in the last year.
Housing costs	Housing costs may provide a good indication of the money available to households to spend on other essential living costs since they account for a significant proportion of a household's expenditure. Poverty indicators are also higher when calculated AHC deductions reflecting that households at the lower end of the income distribution tend to spend a greater proportion of their income on housing. This means low-income household budgets are more sensitive to the effects of fluctuations in housing costs
The cost of food	Income available to a household to spend on essential items such as food is not the only indicator that needs to be considered when examining the potential conditions that may increase vulnerability to food insecurity. The price and affordability of food are also primary determinants of a household's capacity to access the food needed to maintain an adequate diet as well as influencing food choice.
Health indicators associated with poor nutritional quality	Malnutrition refers to a state in which an imbalance of energy and nutrients results in measurable adverse effects on tissue, body shape, size and composition, and/or function. Malnutrition can be a result of undernutrition and overnutrition (obesity) – the double burden of malnutrition. An individual can be underweight or overweight and be malnourished if their diet lacks the nutrients required to maintain healthy function.
Food insecurity and overweight and obesity	The relationship between food insecurity and undernutrition seems intuitively plausible. Paradoxically, food insecurity is also associated with obesity and weight gain. Evidence from the USA has long demonstrated an association between insecure access to food and obesity and weight gain, particularly in women with children (e.g. 67–70). There is also a growing literature demonstrating this relationship in American children, both cross-sectionally and longitudinally. In the absence of a longitudinal measure of food insecurity, it is not possible to directly examine

	the relationship between food insecurity and overweight and obesity status in the UK. However, existing data shows a clear relationship between socio-economic status and weight.

In summary, community diet interventions employ a range of metrics to evaluate changes in food practices among participants, encompassing assessments of food consumption patterns, food preparation and cooking practices, food waste and sustainability practices, and food security and access. By employing a multidimensional approach to assess shifts in food-related behaviours, attitudes, and skills, these interventions enable comprehensive evaluations of their impact on promoting sustainable dietary practices and improving food security within community settings. Table 22 displays a range of toolkits and resources linked to measures and metrics for food practice changes.

Table 22. Resources and toolkits for diet practice change measures and metrics

Source	Description	Link
Every Mouthful Counts toolkit for Local Authorities | Food for the Planet	This toolkit allows you to explore simple food-related actions that can help tackle the climate and nature emergency. For many of the actions, we have been able to calculate estimated GHG emissions savings. All figures are in carbon dioxide equivalent per year, and a link to the sources for each calculation is provided. You can use this toolkit to record the actions of your local council, count up emissions savings, get recognition for taking action, and inspire others to follow suit. You can do so if you are a representative of a Local Authority, or if you are a local food partnership or community group you can record the actions of your local council. To do so, register here to create your own personalised dashboard.	Every Mouthful Counts toolkit for Local Authorities | Food for the Planet
Cyrenians Good Food Handbook	Setting up and running a cooking class, recipes, menu planning and food budgeting (Cyrenians 2012)	Cyrenians Handbook by Tayburn - Issuu
NHS Ayrshire and Arran Healthy Cooking in the Community	A comprehensive manual for the delivery of practical cooking sessions to encourage healthier eating; includes recipes (NHS Ayrshire and Arran 2010)	Healthy Cooking in the Community (communityfoodandhealth.org.uk)
Love Food Hate Waste Cooking classes toolkit (Love Food Hate Waste 2012)	A Love Food Hate Waste interactive cooking classes toolkit. This toolkit provides everything you will need to set up and run your own Love Food Hate Waste cooking classes; with easy to follow lesson plans, activities, recipes, fact sheets and guidance.	LFHW Cooking classes toolkit | Zero Waste Scotland
Scottish Consortium for Learning Disability and the Glasgow Learning Disability Partnership Healthy Eating Healthy Living:	Trainers' pack for teaching healthy eating messages for people with a range of learning disabilities (Scottish Consortium for Learning Disability and the Glasgow Learning Disability Partnership)	Healthy Eating Healthy Living Pack - SCLD

Fife Community Food Project Cooking in the Community in 5 Easy Steps:	Manual developed by Community Food Workers in Fife (Fife Community Food Project 2012)	Cooking in the Community in 5 Easy Steps (communityfoodandhealth.org.uk)
NHS Borders and Scottish Borders Council Joint Health Improvement Team Ready, Steady, Ping!	Microwave cooking resource developed by NHS Borders and Scottish Borders Council Joint Health Improvement Team (2015).	Ready Steady Ping! (communityfoodandhealth.org.uk)
Birmingham City Council Food Justice Intervention Database:	The toolkit organises interventions to address food injustice into five thematic sections, each one tackling a different aspect of the food system pathway.	Food supply and distribution | Food justice intervention database | Birmingham City Council#
Buckinghamshire Council Toolkit: reducing food waste at home:	Basic information on strategies for reducing domestic food waste.	Toolkit: reducing food waste at home | Buckinghamshire Council
Iowa State University Extension and Outreach Community Donation Gardening Toolkit:	This Community Donation Gardening Toolkit is an online resource for community gardeners who are sharing or plan to share produce with neighborhood and community partners to address food insecurity in their local communities.	Community Donation Gardening Toolkit | Iowa State University Extension and Outreach Farm, Food and Enterprise Development (iastate.edu)
Health Care Without Harm Healthy Food Playbook:	The "Delivering community benefit: Healthy food playbook" is a suite of resources to support hospital community benefit professionals and community partners in developing community health interventions that promote healthy food access and healthier food environments.	Delivering community benefit: Healthy food playbook | Healthy food playbook (noharm.org)
Sustain Growing Community Food Enterprises Toolkit:	This toolkit was produced as part of Sustain's Connecting Community Food Enterprises project and aims to support community food projects to develop more sustainably, with tips, tools and guidance.	Growing Community Food Enterprises toolkit | Sustain (sustainweb.org)
Scottish Borders Council Community Food Growing Strategy:	The Community Empowerment (Scotland) Act 2015 aims to help empower communities across Scotland and improve access to land for food growing purposes, for those wanting to grow your own. Scottish Borders Council recognises the benefits of community growing in its many forms and through this Strategy seeks to support and promote community growing across the region	community food growing strategy 2021-26.pdf (scotborders.gov.uk)
Food Standards Agency Qualitative research exploring community food provision:	This research was conducted as a small-scale exploratory piece of work aiming to address the following overarching objectives: How can we ensure that food from community providers is as safe as it should be? How can the FSA best support community providers to comply with food safety guidance? This research aimed to explore how existing community food providers operate, how food safety is managed in these settings, and how the FSA can support these organisations with different aspects of their supply, food handling and operations.	Qualitative research exploring community food provision

Good Food Oxfordshire Cooking Toolkit:	The Good Food Cooking Toolkit is a concise guide to creative cooking without recipes. It can help you create tasty dishes with any ingredients that you have available.	w3b6vefdtnfrlgiu5lq0 (cloudinary.com)
Feeding Britain Affordable Food Club Model Brochure July 2023:	Affordable Food Clubs can include social supermarkets, pantries, larders, food buses and other community-led initiatives which provide access to nutritious food for a fraction of what these items would cost in a regular supermarket. They enable people on low incomes to stretch their budgets further each week, helping to prevent crisis situations from arising in household finances which can bring the need for food banks into play. They also offer wraparound support to address the wider issues with which people may be struggling. Feeding Britain have produced an updated toolkit for organisations seeking to get involved in developing these projects, which outlines some of the considerations for anyone developing an affordable food club.	Final Affordable Food Club Example Booklet Draft (feedingliverpool.org)
Feeding Britain Affordable Food Clubs November 2023 updated brochure:	Feeding Britain have produced an updated toolkit for organisations seeking to get involved in developing these projects, which outlines some of the considerations for anyone developing an affordable food club.	Affordable Food Club Toolkit (Nov 2023).docx (feedingliverpool.org)
Affordable Food Club – A Feeding Britain Toolkit August 2022:	Feeding Britain have produced an updated toolkit for organisations seeking to get involved in developing these projects, which outlines some of the considerations for anyone developing an affordable food club.	Affordable Food Club Toolkit - August 2022.docx (feedingliverpool.org)
Mobile Affordable Food Projects – A Feeding Britain Guide Toolkit August 2022:	Across the Feeding Britain network, a fleet of Mobile Affordable Food Clubs is being developed – converted double decker buses serving inner-city estates and coastal communities; ex-mobile libraries, adapted ice cream vans and retired St John Ambulance vehicles covering urban areas and rural villages; and e-cargo bikes loaded with fruit and vegetables at school gates. These are just some of the mobile affordable food projects being developed across the UK through the Feeding Britain network. Feeding Britain have produced an updated toolkit for organisations seeking to get involved in developing these projects, which outlines some of the considerations for anyone developing a mobile affordable food project.	Mobile Affordable Food Projects – A Feeding Britain Guide Toolkit August 2022 - Feeding Liverpool
Feeding Britain's Mobile Affordable Food Projects Toolkit:	Feeding Britain have produced a toolkit for organisations seeking to get involved in developing these projects, which outlines some of the considerations for anyone developing a mobile affordable food project.	Mobile Affordable Food Projects - A Feeding Britain Guide December 2021 - Feeding Liverpool
Community Growing in Cornwall - report produced with University of Exeter for the Cornwall and Isles	Community growing is sustainable food production that actively engages people within, and for the benefit of, the immediate community. The Community Growing Working Group was asked to: • Define community growing and understand its core	cornwall_1689335885.pdf (sustainablefoodplaces.org)

of Scilly Leadership Board:	characteristics • Survey town and parish councils to assess the level of local council awareness and support of community growing • Interview some of the most successful community growing schemes and develop case studies • Document the multiple health, environmental and socio-economic benefits of community growing and threats to the continued success of community growing in Cornwall • Review the evidence collected to produce findings and recommendations	
Sustainable Food Places Toolkit:	Covers: building a food partnership: Developing a food strategy: Review and refresh	SFP Toolkit | Sustainable Food Places
Sustainable Food Places Engaging with Local Authorities:	The Sustainable Food Places (SFP) approach involves developing a cross-sector partnership of local public agencies, businesses, academics and non-governmental organisations committed to working together to make healthy and sustainable food a defining characteristic of where they live.	Engaging_Local_Authorities.pdf (sustainablefoodplaces.org)
Sustainable Food Places SFP Resources:	To help you on your journey towards becoming a Sustainable Food Place, we have collated examples of What you can do, Guides and toolkits, Local policy, Evidence of impact, Case studies, Webinars and a directory to Who can help.	Resources | Sustainable Food Places
Food For Life FFL Get-Togethers:	Collated examples of What you can do, Guides and toolkits, Local policy, Evidence of impact, Case studies, Webinars and a directory to Who can help	Inspiration | Food for Life Get Togethers (fflgettogethers.org)
The Trussell Trust How to do a social action project:	This toolkit is designed by young people, for young people. We hope that young people like ourselves find this a helpful tool to design and carry out projects and activities of their own; projects which have the power to create positive social change in their local communities and wider.	social_action_toolkit.pdf (trusselltrust.org)
Feedback Food Citizen's Toolkit:	This toolkit provides helpful documents, resources and guidance to maximise your food citizenship projects and campaigns, and the movement towards a fairer, accessible and more sustainable food system.	Food Citizens Toolkit - Feedback (feedbackglobal.org)
Feedback Gleaning Toolkit:	Communities are leading the way in gleaning food from local farms across the UK. Gleaning offers an opportunity for straightforward environmental and social action – food waste on farms is reduced, the complexity of UK food & farming is better understood, communities engage directly in social action, and marginalised communities are able to access more fresh fruit and vegetables.	Gleaning Network - Fighting Food Waste Across the UK (feedbackglobal.org)
An Eden Project Field Guide to Community Food Projects:	By working together, people can influence and improve every aspect of the way food is made, supplied and prepared in their community. This guide will provide you with some ideas and examples of what you could do locally and examples of what other communities have done.	community_food_projects_e-book_0.pdf (edenprojectcommunities.com)

Sustain Toolkit: Ensuring children's access to food 365 days a year:	This toolkit identifies five key target areas where UK food poverty alliances can be effective and advocate for change to improve children's access to food.	Toolkit: Ensuring children's access to food 365 days a year | Sustain (sustainweb.org)
Sustain Making Links: A Toolkit for Local Food Projects (revised edition):	This revised and updated pack is stuffed with information and inspiration for starting up or developing a successful community food project to improve access to good quality, affordable food.	Making Links: A Toolkit for Local Food Projects (revised edition) | Sustain (sustainweb.org)
Social Farms and Gardens, Allotment Site Management Toolkit:	Originally created by our team in Wales in conjunction with the Welsh Government, this comprehensive toolkit aims to help ensure local authorities and others involved in the management of allotment sites maximise the potential of those sites for the local population.	Allotment Site Management Toolkit | Social Farms & Gardens (farmgarden.org.uk)
Feedback, Feeding The 5000 - Introductory Toolkit:	A guide to organizing spectacular and celebratory public events that tackle food waste and build strong movements to achieve real and sustained change. This is a document designed to pool together the collective knowledge and experience of previous Feeding the 5000 event organizers to introduce you to everything you need to know about creating an event of your own. Feedback want to share our knowledge to help the food waste movement grow around the world.	F5K-The-Introductory-Toolkit-1.pdf (feedbackglobal.org)
Feedback, Disco Soup Toolkit:	A guide to organizing spectacular and celebratory public events that tackle food waste	F5K-Disco-Chop-Small-Scale-Event-Toolkit.pdf (feedbackglobal.org)
The FSA Risk Communication Toolkit:	A toolkit and checklist to help our policy, science and strategy teams to plan effective risk communications.	The FSA Risk Communication Toolkit | Food Standards Agency
USDA Community Food Security Assessment Toolkit	This report provides a toolkit of standardized measurement tools for assessing various aspects of community food security. It includes a general guide to community assessment and focused materials for examining six basic assessment components related to community food security.	USDA ERS - Community Food Security Assessment Toolkit

4.0. Physical and mental health/wellbeing measures and metrics

4.1. Introduction

Physical health and wellbeing metrics comprised 3 main types: *anthropometric indicators* (including body mass index (BMI), waist circumference, and body fat percentage) to assess changes in weight status and body composition following dietary interventions, serving as key indicators of obesity-related health outcomes; *blood biomarkers* (including lipid profiles (e.g., cholesterol levels), blood glucose levels, and markers of inflammation (e.g., C-reactive protein) to evaluate metabolic health and assess the risk of chronic diseases such as cardiovascular disease and type 2 diabetes); *self-report assessments*.

Mental well-being metrics included *psychological surveys* (standardised questionnaires, such as the Mental Health Inventory (MHI), the Patient Health Questionnaire (PHQ-9), and the Generalized Anxiety Disorder (GAD-7) scale) utilised to assess various dimensions of mental health, including depression, anxiety, stress, and overall psychological well-being. These measures capture subjective perceptions of mental health status and enable the evaluation of intervention effects on psychological outcomes: *quality of life assessments* (including the Short Form Health Survey (SF-36) and the EuroQol-5 Dimension (EQ-5D) questionnaire) to generate a comprehensive evaluation of participants' overall well-being across physical, psychological, and social domains. These assessments capture subjective perceptions of health-related quality of life and life satisfaction to evaluate the broader impacts of dietary interventions on participants' well-being.

4.2. Review of the evidence for diet and food-related anthropometric and biomarker measures and metrics

Lashkarboulok et al., (2022) reviewed above, include a series of biomarkers along with self-report diet measures in their review (see Table 8).

In an article describing a US intervention in which fruit and vegetables were socially prescribed, Cook et al., (2021) included an array of anthropometric, biomarker and self-report indicators (see next section) to evaluate health improvements (Six-month program offering group-based nutrition and cooking education along with subsidies for fresh produce worth $1 per family member per day, redeemable weekly). Diet indicators were as follows:

- Self-report:

    - Cooking Matters Healthy Eating Behaviours survey, a SNAP-Ed indicator tool
    - Household food security was assessed via the 6-item USDA Household Food Security Survey Module
- Anthropometric (monthly):
    - Height
    - Weight
    - Waist circumference
    - Blood pressure
    - Heart rate
- Biomarker (monthly):
    - HbA1c and lipids measures:
        - Triglycerides
        - High-density lipoproteins
        - Low-density lipoproteins
        - Total cholesterol via non-fasting venous blood sampling.
    - Blood glucose information, with blood glucose measured via non-fasting capillary blood sampling

The Alexandra Rose Charity (2024) produced a report presenting the outcomes of the UK's first large-scale pilots of 'Fruit & Veg on Prescription', which were conducted in the Lambeth and Tower Hamlets boroughs in London. The programme enabled families experiencing food poverty to buy fresh fruit and vegetables at local markets and greengrocers using 'Rose Vouchers' (each person prescribed receives up to £8 per week in vouchers, plus £2 per week for each household member). The Alexandra Rose pilots used a range of anthropometric and self-report indicators to evaluate health improvements:

- Self-report:
    - 4-item Food Frequency Questionnaire
    - 7 items exploring food habits and dietary shift
    - 6-item health and wellbeing changes due to the intervention
    - 2-item Measure Yourself Concerns and Wellbeing (MYCaW)
    - 3 items exploring connection to community and social interaction
    - Frequency of GP visits
- Anthropometric:
    - Blood pressure
    - Weight

With reference to anthropometric measures, Frison et al., (2016) reviewed 21 studies utilising anthropometric indices and measures to assess change in the nutritional status of a population. They concluded that certain metrics *(weight-for-height (WFH); triceps skin fold (TSF); middle-upper arm circumference (MUAC)*) performed well in the detection of short-term changes in the nutritional situation of a population. However, *MUAC performed best* after applying a set of criteria which are critical to successful large-scale rollout (simplicity; acceptability; cost; independence of age; reliability; and accuracy). Metrics tested are set out in Table 23.

Table 23. Anthropometric indices and measures to assess change in the nutritional status of a population (Frison et al., 2016)

Study	Study type	Dependent variables
Bairagi 1980	Longitudinal study	WFA[27]
Bechir et al. 2010	Repeated cross-sectional studies	WFH[28]
Benefice et al. 1984	Longitudinal study	MUAC[29], MC[30], TSF[31], WFH
Block et al. 2003	Repeated cross-sectional studies	WFA, WFH
Branca et al. 1993	Longitudinal study	Height increment, WFH/L[32], H/LFA[33]
Briend et al. 1989	Longitudinal study	Weight, WFA, H/LFA, WFH/L, MUAC
Brown et al. 1982	Longitudinal study	% expected Weight & Height/length gain[34], WFA, H/LFA, WFH/L, MUAC-for-age[35] and TSF-for-age[36]
Chikhungu et al. 2014	Repeated cross-sectional studies	WFH/L, WFA, HFA
Egata et al. 2013	Longitudinal study	Weight, WFH/L, MUAC
Garenne et al. 2012	Cohort	Weight, length, HC[37], MUAC, TSF, SSF[38], MC, BMI, WFA, WFH/L
Hillbruner et al. 2008	Repeated cross-sectional studies	% expected growth, WFH/L, H/LFA
Huong et al. 2014	Repeated cross-sectional studies	Height, weight, WFH/L, WFA,H/LFA
Loutan et al. 1984	Cohort	WFH/L, MUAC, TSF
Marin et al. 1996	Longitudinal study	WFH/L, WFA, H/LFA
Martin-Prevel et al. 2000	Repeated cross-sectional studies	Birth weight, WFH/L, H/LFA
Meshram et al. 2014	Repeated cross-sectional studies	WFH/L, WFA, H/LFA
Miller et al. 2013	Nested cohort in cross-sectional survey	WFH/L, H/LFA, WFA, MUAC-for-age, TSF-for-age
Mude, et al. 2006	Secondary data analysis	MUAC
Panter-Brick 1997	Longitudinal study	Weight, Height, WFH/L, WFA, L/HFA

[27] Weight-for-age (WFA)
[28] Weight-for-height (WFH)
[29] Middle-upper arm circumference (MUAC)
[30] Muscular circumference (MC)
[31] Triceps skin fold (TSF)
[32] Weight-for-height/length (WFH/L
[33] Height/Length-for-age (H/LFA)
[34] % expected weight & Height/length gain
[35] MUAC-for-age
[36] TSF-for-age
[37] Head circumference (HC)
[38] Subscapular skinfold (SSF)

Shell-Duncan 1995	Longitudinal study	Weight, Height, MUAC, BMI, WFH/L, MUAC-for-Age, WFA, H/LFA
Wright et al. 2001	Growth monitoring	WFA

Sommer et al., (2020) reviewed 32 studies to assess the use and performance of 4 anthropometric metrics to determine obesity (body mass index (BMI); waist circumference (WC); waist to hip ratio (WHR); waist to height ratio (WHtR).

The majority of reviewed studies used BMI and WC as obesity measures. The pooled results of the meta-analyses consistently rendered low sensitivities and relatively high specificities for BMI and WC when compared to imaging techniques as reference standards. The data were insufficient to pool the results for waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) but were similar to BMI and WC. BMI and WC have serious limitations for use as obesity screening tools in clinical practice despite their widespread use. No evidence supports that WHR and WHtR are more suitable than BMI or WC to assess body fat. However, due to the lack of more accurate and feasible alternatives, BMI and WC might still have a role as initial tools for assessing individuals for excess adiposity until new evidence emerges.

Dinu et al., (2020) conducted a review of meta-analyses of 80 articles involving anthropometric and cardiometabolic measures of popular diets. The strength of evidence was generally weak. The most consistent evidence was reported for the Mediterranean diet, with suggestive evidence of an improvement in weight, BMI, total cholesterol, glucose, and blood pressure. Suggestive evidence of an improvement in weight and blood pressure was also reported for the DASH diet. Low-carbohydrate, high-protein, low-fat, and low glycaemic-index/load diets showed suggestive and/or weak evidence of a reduction in weight and BMI, but contrasting evidence for lipid, glycaemic, and blood pressure parameters, suggesting potential risks of unfavourable effects. Evidence for palaeolithic, intermittent energy restriction, Nordic, vegetarian, and portfolio dietary patterns was graded as weak. Among all the diets evaluated, the Mediterranean diet had the strongest and most consistent evidence of a beneficial effect on both anthropometric parameters and cardiometabolic risk factors. A summary of outcome measures appears in Table 24.

Table 24. Outcome measures from meta-analyses of RCTs included in the umbrella review of dietary interventions (Dinu et al., 2020)

Study type	Study	Outcome measures
LC[39]	Nordmann et al.	Weight, TC[40], LDL-C[41], HDL-C[42], TG[43], SBP[44], DBP[45]
LC	Hession et al	Weight, TC, LDL-C, HDL-C, TG, glucose, SBP, DBP
LC	Hu et al	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, SBP, DBP
LC	Santos et al	Weight, BMI, LDL-C, HDL-C, TG, glucose, insulin, HbA1c[46], SBP, DBP
LC	Ajala et al.	HbA1c
LC	Bueno et al.	Weight, LDL-C, HDL-C, TG, SBP, DBP
LC	Naude et al.	Weight
LC	Alexandraki et al	Weight
LC	Sackner-Bernstein et al	Weight
LC	Fan et al.	Weight, HbA1c
LC	Hashimoto et al	Weight
LC	Mansoor et al.	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, SBP, DBP
LC	Steckhan et al.	Weight, insulin
LC	Meng et al.	Weight, TC, LDL-C, HDL-C, TG, glucose, HbA1c
LC	Snorgaard et al.	Weight, BMI, LDL-C, HbA1c
LC	Huntriss et al.	Weight, TC, LDL-C, HDL-C, TG, HbA1c, SBP, DBP
LC	Sainsbury et al	Weight, HbA1c
LC	van Zuuren et al	Weight, BMI, LDL-C, HDL-C, TG, glucose, HbA1c, SBP, DBP
LC	Gjuladin-Hellon et al.	TC, LDL-C, HDL-C, TG
LC	Korsmo-Haugen et al.	Weight, TC, LDL-C, HDL-C, TG, HbA1c, SBP, DBP
LC	McArdle et al.	Weight, HbA1c
HP[47]	Santesso et al	Weight, BMI, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
HP	Wycherley et al	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, SBP, DBP
HP	Ajala et al	HbA1c
HP	Dong et al	Weight, TC, LDL-C, HDL-C, TG, glucose, HbA1c, SBP, DBP
HP	Schwingshackl & Hoffman	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
HP	Clifton et al	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
HP	Johansson et al	Weight
HP	Zhao et al	Weight, BMI, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
LF[48]	Astrup et al	Weight
LF	Avenell et al	Weight
LF	Schwingshackl & Hoffman	TC, LDL-C, HDL-C, TG
LF	Wu et al	TC, LDL-C, HDL-C, TG
LF	Boaz et al	Weight

[39] Low-carbohydrate diet
[40] Total cholesterol
[41] LDL cholesterol
[42] HDL cholesterol
[43] Triglyceride
[44] Systolic blood pressure
[45] Diastolic blood pressure
[46] Glycated haemoglobin
[47] High-protein diet
[48] Low-fat diet

LF	Hooper et al	Weight, BMI, TC, LDL-C, HDL-C, TG, SBP, DBP
LF	Tobias et al	Weight
LF	Steckhan et al	Weight
LF	Lu et al	TC, LDL-C, HDL-C, TG, SBP, DBP
Palaeolithic diet	Manheimer et al	HDL-C, TG, glucose, SBP, DBP
Palaeolithic diet	Ghaedi et al	Weight, BMI, TC, LDL-C, HDL-C, TG, SBP, DBP
LGI/LGL[49]	Opperman et al.	TC, LDL-C, HDL-C, TG, HbA1c
LGI/LGL	Thomas et al	Weight, BMI, TC, HDL-C, TG, glucose, insulin
LGI/LGL	Thomas and Elliott	HbA1c
LGI/LGL	Ajala et al.	HbA1c
LGI/LGL	Fleming and Godwin	TC, LDL-C, HDL-C, TG
LGI/LGL	Goff et al.	TC, LDL-C, HDL-C, TG
LGI/LGL	Schwingshackl and Hoffmann	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
LGI/LGL	Wang et al.	HbA1c
LGI/LGL	Clar et al.	Weight, BMI, TC, LDL-C, HDL-C, TG, SBP, DBP
LGI/LGL	Evans et al.	SBP, DBP
LGI/LGL	Ojo et al.	Glucose, HbA1c
LGI/LGL	Zafar et al.	Weight, BMI, TC, LDL-C, HDL-C, TG, glucose
IER[50]	Alhamdan et al.	Weight
IER	Headland et al.	Weight
IER	Cioffi et a	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
IER	Harris et al.	Weight
IER	Harris et al	Weight, TC, LDL-C, HDL-C, TG, glucose, insulin
IER	Roman et al	Weight
MD[51]	Esposito et al.	Weight, BMI
MD	Kastorini et al	HDL-C, TG, glucose, SBP, DBP
MD	Nordmann et a	Weight, BMI, TC, LDL-C, HDL-C, glucose, insulin, SBP, DBP
MD	Ajala et al.	HbA1c
MD	Huo et al	Weight, BMI, TC, LDL-C, HDL-C, TG, glucose, insulin, HbA1c, SBP, DBP
MD	Esposito et a	HbA1c
MD	Garcia et al.	HDL-C, TG, glucose, SBP, DBP
MD	Gay et al.	SBP, DBP
MD	Ndanuko et al.	SBP, DBP
MD	Nissensohn et a	SBP, DBP
MDs	Rees et al.	TC, LDL-C, HDL-C, TG, SBP, DBP
Nordic diet	Ndanuko et al.	SBP, DBP
Nordic diet	Ramezani-Jolfaie et al.	TC, LDL-C, HDL-C, TG, SBP, DBP

[49] Low-glycemic-index/low-glycemic-load diet
[50] Intermittent energy restriction
[51] Mediterranean diet

VGT[52]	Yokoyama et al.	SBP, DBP
VGT	Yokoyama et a	Glucose, HbA1c
VGT	Barnard et a	Weight
VGT	Huang et al.	Weight
VGT	Wang et al.	Weight, TC, LDL-C, HDL-C, TG
VGT	Yokoyama et al.	TC, LDL-C, HDL-C, TG
VGT	Picasso et al.	HDL-C, TG, glucose, SBP, DB
VGT	Viguiliouk et al.	Weight, BMI, LDL-C, HDL-C, TG, glucose, HbA1c, SBP, DBP
VGT	Lopez et al	SBP, DBP
DASH diet	Shirani et al.	Glucose, insulin
DASH diet	Saneei et al	SBP, DBP
DASH diet	Siervo et a	TC, LDL-C, HDL-C, TG, glucose, SBP, DBP
DASH diet	Gay et al.	SBP, DBP
DASH diet	Ndanuko et a	SBP, DBP
DASH diet	Soltani et al	Weight, BMI
Portfolio dietary pattern	Chiavaroli et al.	Weight, TC, LDL-C, HDL-C, TG, SBP, DBP

With reference to other dietary biomarker measures, Baldrick et al., (2011) reviewed 96 studies using biomarker metrics in diet interventions targeted to increasing fruit and vegetable consumption. They found that the most commonly measured, and most consistently responsive, biomarkers were the carotenoids and vitamin C. The biomarkers (and non-biomarker metrics) included the following:

- Increase in fruit and vegetable intake (servings/d)
- α-carotene
- β-carotene
- β-cryptoxanthin
- Lycopene
- Lutein
- Zeaxanthin
- Lutein + zeaxanthin
- Vitamin C

General Fruit and Vegetable Intake – Carotenoids as Biomarkers: Alpha- and β-carotene, lutein, and lutein/zeaxanthin increased significantly in 74%, 76%, 71%, and 69% of the general fruit and vegetable studies that measured them, respectively. *Lycopene decreased significantly in four studies.*

[52] Vegetarian diet

General Fruit and Vegetable Interventions – Vitamin C as a Biomarker: *Vitamin C increased significantly in 21 out of 29 (72%) studies* in the "whole diet" and "mixed fruit and vegetable" sections. Its use as a biomarker of fruit and vegetable intake may, however, be limited in already well nourished populations as the relationship between vitamin C intake and plasma concentration is linear only up to a certain threshold.

General Fruit and Vegetable Interventions – Other Potential Biomarkers: Relatively few mixed fruit and vegetable studies have assessed other potential single biomarkers of fruit and vegetable consumption, such as quercetin or potassium, and therefore further work must establish whether these nutrients do respond to a mixed fruit and vegetable intervention.

Biomarkers of Individual Fruit and Vegetables: In general, studies examining the effects of increased consumption of individual types of fruit and vegetables demonstrated significant increases in several biomarkers of interest across studies from several different countries, of varying duration (1–24 weeks) and employing different levels of control ranging from provision of key foods with consumption in a free living situation, through to supplying the total diet which was then consumed under close supervision.

In general, fruit and vegetable intervention studies of different type, duration, design, and intensity demonstrated significant increases in several biomarkers of intake. The data presented indicates that a panel of biomarkers (notably α- and β-carotene, vitamin C, lutein, zeaxanthin, and β-cryptoxanthin) should be measured as indicators of compliance in fruit and vegetable intervention trials.

Picó et al., (2019) discuss the challenge within nutritional studies as obtaining valid and reliable assessment of food intake, as well as its effects on the body (generally, food intake measurement is based on self-reported dietary intake questionnaires, which have inherent limitations). They suggest the use of biomarkers, capable of objectively assessing food consumption without the bias of self-reported dietary assessment. Another major goal is to determine the biological effects of foods and their impact on health. Systems analysis of dynamic responses may help to identify biomarkers indicative of intake and effects on the body at the same time, possibly in relation to individuals' health/disease states. They review a range of suggested biomarkers and prevalence of their use in other studies, which are displayed in Table 25.

They concluded that acquisition of food intake information by the consumer via mobile appliances can be translated by image recognition software allowing for efficient

identification of food ingredients. Combining this information with a personal integrative nutritional biomarker profile, would optimally help providing more adequate, precision nutrition recommendations. Additional physiological information, for example to monitor glucose levels, may be provided by wearables. The use of specifically designed platforms, for example, user-friendly mobile applications, capable of integrating all this available information and translating it into specific outcomes, is expected to help empowering citizens to have healthier optimal behaviours and lifestyle adaptations

Table 25. Examples of suggested nutritional biomarkers related with exposure and/or effects of macronutrients, food or dietary patterns, in samples obtained with non-invasive or minimally invasive techniques (Picó et al., 2019)

Proposed Biomarker	**Sample Type**	**Intended Use (As Nutritional Biomarker)**	**References**
Alkylresorcinols	Plasma	Whole-grain food consumption	Original research [14,15] Reviewed in Reference [16]
Allyl methyl sulfoxide (AMSO) or allyl methyl sulfone ($AMSO_2$)	Urine	Intake of garlic	Original research [17] BFIRev ** [18]
Allyl methyl sulphide (AMS)	Urine/breath	Intake of garlic	Original research [17,19,20] BFIRev [18]
Arbutin	Plasma	Pear intake	Original research [21] BFIRev [22]
Carotenoids	Plasma	Fruit and vegetable intake	Systematic review and meta-analysis [23]
Carotenoids with Vitamin C	Plasma/serum	Fruit and vegetable intake Combined marker (suggested as better biomarker than carotenoids or vitamin C alone)	Reviewed in Reference [24]
Creatine	Serum	Intake of meat and fish	Reviewed in Reference [25]
Creatinine	Urine	Intake of meat and fish	Reviewed in Reference [25]
Daidzein	Urine/plasma	Intake of soy or soy-based products	Systematic review [26]
Dyhydrocaffeic acid derivatives	Urine	Acute and habitual exposure to coffee	Original research [27,28,29] Reviewed in Reference [30]
Erythronic acid, alone or with fructose and/or sucrose	Urine	Sugar intake Combined marker	Original research [31]
Genistein	Urine/plasma	Intake of soy or soy-based products	Systematic review [26]
Homocysteine	Plasma	One carbon metabolism and folate status	Reviewed in References [32,33]
Hydroxylated and sulfonated metabolites of esculeogenin B	Urine	Intake of tomato juice	Original research [34]
1-Methylhistidine	Urine	Meat and oily fish consumption	Original research [27,35,36] Reviewed in References [30,37]
n-3 fatty acids: docosahexaenoic acid (DHA)	Blood: erythrocytes or platelets	DHA status	Systematic review [38]

n-3 fatty acids: DHA (as phospholipid)	Plasma	DHA status	Systematic review [38]
n-3 fatty acids: eicosapentaenoic acid (EPA as phospholipid)	Plasma	EPA status	Systematic review [38]
N-acetyl-*S*-(2carboxypropyl)cysteine (CPMA)	Urine	Intake of onion and garlic	Original research [39] BFIRev [18]
Nitrogen[53]	Urine (24h)	Protein intake	Reviewed in Reference [40]
O-acetylcarnitine	Urine	Red-meat consumption	Original research [41] Reviewed in Reference [42]
Pentadecanoic acid (C15:0)	Plasma/serum	Total dairy fat intake	Reviewed in Reference [43]
Phenylacetylglutamine	Urine	Vegetable intake	Original research [41] Reviewed in Reference [30]
Phloretin	Urine	Apple intake	Original research [44,45] BFIRev [22]
Phloretin glucuronide	Urine	Apple intake	Original research [46,47] BFIRev [22]
Proline betaine	Urine	Acute and habitual citrus exposure	Original research [27,48,49] Reviewed in Reference [30]
S-allylcysteine (SAC)	Plasma	Intake of garlic	Original research [19] BFIRev [18]
S-allylmercapturic acid (ALMA)	Urine	Intake of garlic	Original research [50] BFIRev [18]
Urolithin B	Urine	Intake of ellagitannins (present in fruits as strawberries, raspberries and walnuts and oak-aged red wine, among others)	Original research [51]

4.3. Review of the evidence for diet and food-related wellbeing self-report measures and metrics

Cooke et al., (2016) consider a range of measures (42), not exclusively specific to diet interventions. A diverse range of instruments was utilised, as well as diversity in the way well-being was conceptualised and measured. Different terms were often used to refer to loosely similar constructs of well-being (e.g., "happiness", "life satisfaction" and "wellness"). Likewise, there was little distinction between "quality of life" (QoL) and "subjective wellbeing" in some instruments. Essentially, there was an inconsistent use of terminology and definitions likely to create confusion for researchers.

The most comprehensive measures of well-being reviewed tended to be those designed to measure QoL, making these instruments useful for comprehensive assessments of health and well-being.

[53] Nitrogen in 24 h urine is an already substantially validated biomarker of protein intake. ** BFIRev: Biomarker of Food Intake Review. This type of review follows specific recent guidelines for the review, identification and/or validation of candidate biomarkers of food intake [52].

Life satisfaction was the focus of many of the instruments and was frequently synonymous with well-being. The degree of evidence provided to document the validity of several instruments was minimal, and there seemed to be a reliance on face validity in many cases. A summary of instruments is displayed in Table 26.

Table 26. Overview of well-being instruments (Cooke et al., 2016)

Instrument	Citation	Definition
Hedonic Australian Unity Index of Subjective Well-Being	Cummins, Eckersley, Pallant, Van Vugt, & Misajon, 2003	Measures overall life satisfaction and seven domain-specific areas of satisfaction (standard of living, health, achievement in life, personal relationships, how safe you feel, community connectedness, and future security)
Delighted-Terrible Scale	Andrews & Crandall, 1976	Measures feelings regarding domain specific and global life satisfaction over the past year on Likert-type scale ranging from delighted to terrible
European Social Survey Happiness Item	European Social Survey, 2014	"Taking all things together, how happy would you say you are with your life?" (p. 14).
Happiness Measures	Fordyce, 1988	Measures level of happiness and average percentage of time when one feels happy, unhappy, or neutral.
Ladder of Life Scale	Cantril, 1965	"Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you personally say you stand?"
Life Satisfaction Research Questionnaire	Hagedorn, 1996	Measures satisfaction with past circumstances, what one made of those past circumstances, and total satisfaction.
MIDUS II–Satisfied With Life item	Ryff et al., 2007	"At present, how satisfied are you with your life?" (p. 91)
National Survey, University of Michigan–Happiness Item	Gurin, Veroff, & Feld, 1960	"Taking all things together, how would you say things are these days— would you say that you are very happy, pretty happy, or not too happy?"
Satisfaction With Life Scale	Diener, Emmons, Larsen, & Griffin, 1985	"A global assessment of a person's quality of life according to his own chosen criteria" (Shin & Johnson, as cited in Diener et al., 1985, p. 71).
Short Depression Happiness Scale	Joseph, Linley, Harwood, Lewis, & McCollam, 2004	Measures level of depression and happiness
Subjective Happiness Scale	Lyubomirsky & Lepper, 1999	Measures level of happiness and comparison of level of happiness to others
World Values Survey	World Values Survey, 2012	"All things considered, how satisfied are you with your life as a whole these days?" (p. 3).
Eudaimonic Basic Needs Satisfaction in General	Johnston & Finney, 2010	"Needs [for autonomy, competentness, and relatedness] are innate, psychological, and essential for well-being" (p. 280).
Flourishing Scale	Diener et al., 2010	"Designed to measure social-psychological prosperity" (p. 144) as defined by positive social relationships, purposeful and meaningful life, engagement and interest in one's activities, and feeling competent and capable in activities that are important to the individual.
Questionnaire for Eudaimonic Well-Being	Waterman et al., 2010	Measures ". . .well-being incorporating both subjective and objective elements. The subjective elements are experiences of eudaimonia/ feelings of personal expressiveness. The objective elements include those behaviours involved in the pursuit of eudaimonic goals such as self-realization entailing the identification and development of personal potentials and their utilization in ways that give purpose and meaning to life" (p. 43).
Scales of Psychological Well-Being	Ryff, 1989	meaning to life" (p. 43). Scales of Psychological Well-Being Ryff, 1989 6 120 .86–.93 .81–.88 1 Measures self-acceptance, positive relations

		with others, autonomy, environmental mastery, purpose in life, and personal growth.
Social Well-Being Scale	Keyes, 1998	Measures social aspects of well-being, including meaningfulness of society, social integration, acceptance of others, social contribution, and social actualization.
Quality of life Assessment of Quality of Life–8D	Richardson, Iezzi, Khan, & Maxwell, 2014	Measures level of happiness, presence of negative symptoms, coping abilities, positive social relationships, sense of self-worth, ability to live independently, level of pain, and functioning of senses (vision, hearing, and communication).
Comprehensive Quality of Life Scale	Cummins, McCabe, Romeo, & Gullone, 1994	Measures life satisfaction subjectively, objectively, and weighted by importance according to the respondent.
Quality of Life Inventory	Frisch, Cornell, Villanueva, & Retzlaff, 1992	Measures overall life satisfaction, consisting of the sum of satisfaction in particular areas of life.
WHO Quality of Life Scale	WHOQOL Group, 1998	"Individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the persons' physical health, psychological state, level of independence, social relationships and their relationship to salient features of their environment" (p. 1570).
Wellness Five Factor Wellness Evaluation of Lifestyle	Lonborg, 2007 (Myers & Sweeney	Measures five second-order factors identified as the creative self, the coping self, the social self, the essential self, and the physical self
Life Assessment Questionnaire – Wellness Assessment Questionnaire	Palombi, 1992 (Hettler and the National Wellness Institute)	"Designed to help students assess their current level of wellness and the potential risks or hazards that they choose to face at that point in their life" (p. 221). Measures the 10 dimensions of physical fitness, nutrition, self-care, drugs and driving, social environment, emotional awareness, emotional control, intellectual, occupational, and spiritual.
Optimal Living Profile	Renger et al., 2000	"Wellness represents the optimum state of well-being that each individual is capable of achieving, given his or her own set of circumstances . . . . Wellness embodies a way of living that encourages individuals to seek a balance in their lifestyle designed to improve the quality of life" (p. 404). Measures environmental, intellectual, spiritual, emotional, social, and physical health.
Perceived Wellness Survey	Adams, Bezner, & Steinhardt, 1997	"The Perceived Wellness Survey is a slautogenically-oriented, multidimensional measure of perceived wellness perceptions in the physical, spiritual, psycho
TestWell	Owen, 1999	"Wellness is the process by which one responsibly identifies areas of life in need of improvement and subsequently makes choices conducive to a more satisfying lifestyle . . . . [TestWell] measures the extent to which lifestyle behaviours reflect potential risks and hazards" (p. 180).
Wellness Evaluation of Lifestyle	Farmer, 2005 (Myers, Sweeney, & Witmer	Wellness is defined as "a way of life oriented toward optimal health and well-being in which the body, mind, and spirit are integrated by the individual to live more fully within the human and natural community" (Myers, Sweeney, & Whitmer, as cited in Farmer, 2005).
Wellness Inventory	Palombi, 1992 (J. W. Travis	"Growth oriented. . . measurement designed to stimulate new ways of approaching personal issues" (p. 221). Measures self-responsibility and love, breathing, sensing, eating, moving, feeling, thinking, playing and working, communicating, sex, finding meaning, and transcending.
Composite 12-Item Well-Being Questionnaire	Pouwer, Van der Ploeg, Ader, Heine, & Snoek, 1999	Measures negative affect, positive affect, and energy
Authentic Happiness Inventory	Zabihi, Ketabi, Tavakoli, & Ghadiri, 2014	Designed to measure pleasure, engagement, meaning in life, and interpersonal connectedness as components of happiness.
COMPAS-W	Gatt, Burton, Schofield, Bryant, & Williams, 2014	Measures life satisfaction, mastery, achievement, positivity, composure, and own worth

Gallup Healthways Well-Being Index	Gallup-Healthways, 2014	Measures purpose, social relationships, financial management and
General Well-Being Schedule	Fazio, 1977	"Self-representations of subjective well-being and distress
Life Satisfaction Index	Neu Garten, Havighurst, & Tobin, 1961	Measures the extent to which one takes pleasure from the round of activities that constitute everyday life; regards life as meaningful and accepts resolutely that which life has been; feels one has succeeded in achieving major goals; holds a positive image of self; and maintains happy and optimistic attitudes and mood.
Medical Outcome Studies Short-Form 36 Health Survey	McHorney, Ware, Lu, & Sherbourne, 1994; McHorney, Ware, & Raczek, 1993	McHorney, Ware, Lu, & Sherbourne, 1994; McHorney, Ware, & Raczek, 1993
Mental Health Continuum Short Form	Keyes et al., 2008	Emotional well-being is defined as positive affect/satisfaction with life; social well-being is defined by Keyes's five factors of social acceptance, social actualization, social contribution, social coherence, and social integration; psychological well-being is defined by Ryff's six factors of self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth
Oxford Happiness Inventor	Argyle, Martin, & Crossland, 1989	A broad measure of personal happiness designed to mirror the Beck Depression Inventory in format
Oxford Happiness Questionnaire	Hills & Argyle, 2002	"a broad measure of personal happiness" (p. 1073).
Pemperton Happiness Index	Hervás & Vázquez, 2013	Covers multiple domains of well-being (i.e., general, hedonic, eudaimonic, and social), assesses overall remembrance of well-being and experience of well-being yesterday, and is validated in multiple countries and languages.
Psychological General Well-Being Index–Revised	Revicki, Leidy, & Howland, 199	"Designed to measure self-representations of interpersonal affective or emotional states reflecting a sense of subjective well-being or distress" (p. 419).
Warwick-Edinburgh Mental Well-Being Scale	Tennant et al., 2007	"A wide conception of well-being, including affective-emotional aspects, cognitive-evaluative dimensions and psychological functioning . . . by focusing wholly on the positive" (p. 64).
WHO-Ten Well-Being Index	Bech, Gudex, & Staehr Johansen, 1996	Measures the absence of negative symptoms (i.e., anxiety, depression) and the presence of positive symptoms (e.g., energy).

Polley et al., (2021) conducted an evidence review in which the authors tabulated a range of health outcomes across the reviewed studies pertaining to health-related, and wider health-related outcomes measures. There is some overlap with social outcomes. The summary is presented in Table 27.

All but two studies reported wider determinants of health in the form of social connections, and/or outcomes related to health by measuring wellbeing and quality of life. These remaining two studies reported only mental health and physical health; the former used a mental health social value calculator, and the latter the International Physical Activity Questionnaire. Both studies indicated that participation was associated with positive outcomes on these metrics.

One study included broader individual outcomes relating to social education, housing, income, wellbeing, and physiological factors; although there was limited detail on collection methods, follow up, or sampling approach.

Social outcomes were measured with a range of tools looking at connections and loneliness, including: the Campaign to End Loneliness Tool, R-Outcomes, UCLA Loneliness Scale, ULS-8, De Jong Gierveld Scale, Work and Social Adjustment Scale, community belonging scale, social support rating, a social capital questionnaire, Likert-scale questions, and number of group memberships. Some measures were unspecified.

Wellbeing and quality of life outcomes were commonly included, with 27 of the 32 included studies using: the (predominantly Short) WEMWBS, ONS personal wellbeing measures, EQ5D, EQ-VAS, MYCaW, Wellbeing Star, PAM, wellbeing goal achievement measure, 5 Ways to Wellbeing, and WHO-5.

Five of the 32 included studies reported outcome measures in other domains. Four of these five reported additional physiological outcomes (the Rockwood Frailty Scale, and change in physical activity).

Table 27. Domains, outcome measures and follow-up period for all included additional studies (Polley et al., 2021)

	Wider determinants of health					Outcomes related to health			
Study	**Work & volunteering**	**Social**	**Education & skills**	**Housing**	**Income**	**General health & wellbeing**	**Physiological**	**Psychological**	**Empowerment**
Benson et al. 2021		R-Outcomes before and after, social contact +, loneliness unclear							
Bristol Ageing Better 2018		De Jong Gierveld Loneliness Scale, UCLA, +* postintervention, + at 3m (sample size too small)				SWEMWBS, +* postintervention, + at 3m (sample size too small)			

Bromley by Bow 2018		WSAS, before and after, + but not clinically significant				MYCaW, SWEMWBS, +* before and after			
Bromley by Bow 2019						MYCaW +*, ONS4 + (anxiety only +*), last SP session			
Dayson & Leather 2018		Connectedness and relationships, measure not specified, + at 3m				EQ-VAS, EQ5D5L, SWEMWBS, + at 3m			
Dayson & Leather 2020		Measure not specified, + at 3m				EQ-VAS, EQ5D5L, SWEMWBS, all + at 3m			
Elston et al 2019						Wellbeing Star, WEMWBS, PAM, wellbeing goal achievement + at 12w or exit	Rockwood Clinical Frailty Scale, + at 12w or exit		
Ferguson & Hogarth 2018		UCLA, + at 3m (although - in subsample)							
Fullwood 2018						SWEMWBS, +* at post-intervention and 2m			
Giebel et al. 2021						SWEMWBS score at 3m +* and 6m +*			
Hackney 2020		Unspecified lonelines s and				SWEMWBS, +* at discharge, 3m	Rockwood Clinical Frailty Scale,	Mental health score, follow up	

		isolation questionnaire, + at unspecified follow-up				sample too small	follow-up and result NR	and result NR	
Healthy Dialogues 2018						Wellbeing Star at each appointment, +*			
Healthy Dialogues 2021						Wellbeing Star at each appointment, +*			
Healthy London Partnership 2018		Measure and follow-up unspecified, n=19 +	Measure and follow-up unspecified, n=1 +	Measure and follow-up unspecified, n=7 +	Measure and follow-up unspecified, n=15 +	Wellbeing Star plus 3 individual outcomes, +, follow-up unspecified	Measure and follow-up unspecified, n=12 +		
ICC YPSP 2020		One Likert scale question for lonelines s, mixed across sites at 6m, some small sample sizes				ONS personal wellbeing scores +, SWEMWBS + (not 'meaningful') at 6m	Physical activity based on definition of 'active' by UK Chief Medical Officer, + by 7% at 6m		
ICC Redbridge 2020		Campaign to End Lonelines s Tool +, social capital questionnaire + for networks /support, 6m				ONS, EQ-VAS, EQ5D -5L, SWEMWBS, MYCaW, +* for all at 6m (ONS life satisfaction only)			
ICC City & Hackney 2020						EQ5D -5L -, SWEMWBS + (not 'meaningful'), at 3 and 6m			

Islington Giving 2019						WEMWBS, meaningful + at 6w			
Kellezi et al. 2019		No. group memberships +*, UCLA scale +, 4m							
Massie & Ahmad 2019		De Jong Gierveld Loneliness Scale, +* at 1 - 10m (overall and sub - scale)				ONS, +* at 1 - 7m (overall and sub - scale)			
Metropolitan Thames Valley 2019								HACT mental health social value, + post - intervention	
Oxfordshire Mind 2020						SWEMWBS, 78% +* at end of intervention			
Oxfordshire Mind 2021						SWEMWBS, 71% +* at end of intervention			
Oxfordshire Mind 2021						SWEMWBS, at least 62% +* (reporting conflict) at end of intervention			
Pescheny et al. 2019						SWEMWBS, +* post - intervention (though mean change			

						not clinically relevant)			
Peschenyet al. 2019							International Physical Activity Questionnaire, + post - intervention		
Polley et al. 2019		De Jong Gierveld Scale, +* at 3m				MYCaW, +* at 3m, PAM, clinical significance at 3m			
Wakefield et al. 2020		No. group memberships + at 4m then – at 6 - 9m, community belonging scale, social support rating, ULS -8, 4m and 6 -9m NR				EQ5D, + at 4m and maintained at 6-9m			
Walsall Council 2020		De Jong Gierveld Scale, follow - up unspecified, 52% less lonely, 13% more				5 Ways to Wellbeing +, WHO - 5 +, follow -up unspecified		PHQ -9, follow - up unspecified, 6/10 +, 1/10	
Woodall et al. 2019		Campaign to End Loneliness Measure, +* post - intervention				WEMWBS, EQ5D, +* post - intervention			
York CVS 2019	Measure unspecified, 21% > in	Campaign to End Loneliness				SWEMWBS, +* at 3m	Measure unspecified, 21% > in		

	volunteering at 3m	Measure, +* at 3m					exercise at 3m		

Carson et al., (2014) reviewed 24 diet interventions and their impact on participant wellbeing. The standardised quantitative *Short Form–36 Health Survey* was the most widely used instrument to assess quality of life/wellbeing (comprising subscales assessing both physical and mental wellbeing). The physical/mental health/wellbeing scales were used across interventions to evaluate wellbeing are displayed in Table 28.

Table 28. Summary of wellbeing and quality of life scales in reviewed studies (Carson et al, 2014)

Study	Design, setting	QOL instrument used
Ackerman et al	RCT, clinical	SF-36[54] and QWB-SA[55]
Barham et al	RCT, worksite	HRQOL SF-12 [56], IWQOL [57], 3-Factor Eating Questionnaire
Blissmer et al	Cohort, clinical	SF-36
Darga et al	RCT, community	FACT-An[58] and FACT-G[59]
Davis et al	RCT, clinic/university	SF-36 and IWQOL-Lite
Evangelista et al	RCT, clinical	Minnesota Living With Heart Failure questionnaire
Fontaine et al	RCT, community	SF-36, BDI[60]
Heshka et al	RCT, clinic	SF-36 and IWQOL-Lite
Imayama et al	RCT, community and cancer research center	SF-36
Kennedy et al	RCT, community	IWQOL
Ladson et al	RCT, clinical	PCOS[61] HRQOL
Malone et al	Cohort, university	SF-36
Melanson et al	RCT, community	SF-36
Pope et al	RCT, community	SF-36
Rejeski et al	RCT, university	SF-36
Rippe et al	Randomized prospective trial, Weight Watchers International	SF-36
Ross et al	Cohort, community	SF-36

[54] SF-36, Short Form–36 Health Survey
[55] QWB-SA, Quality of Well-Being Scale–Self-administered
[56] HRQOL, Health-Related Quality of Life
[57] IWQOL, Impact of Weight on Quality of Life
[58] Functional Assessment of Cancer Therapy–Anaemia
[59] Functional Assessment of Cancer Therapy–General
[60] BDI, Beck Depression Inventory
[61] PCOS, polycystic ovarian syndrome

Villareal et al	RCT, university	SF-36
Villareal et al	RCT, university	SF-36
von Gruenighen et al	RCT, clinical/community	FACT-G
Williamson et al	RCT, multi-site clinical	SF-36, BDI-II
Wolf et al	RCT, university	SF-36
Womble et al	RCT, community	SF-36

Chatterjee et al., (2018) reviewed 86 social prescribing interventions. Over half did not report any evaluation. Of those that did, 14 interventions used standardised quantitative interventions to evaluate physical/mental wellbeing as displayed in Table 29.

Of the 17 studies that conducted quantitative evaluation, 14 studies employed one to four standardised measurement scales comprising:

- **Anxiety**: Generalized Anxiety Disorder Assessment: (GAD-7: Spitzer, Kroenke, Williams, & Löwe, 2006);
- **Cost effectiveness**: Quality Adjusted Life Year (QALY: Drummond et al., 2009); EuroQol-5D (EQ-5D: Szende, Oppe, & Devlin, n2007);
- Depression: Patient Health Questionnaire: (PHQ-9: Spitzer, Kroenke, Williams & Löwe, 2006)
- **Functional status (health and wellbeing):** Dartmouth CO-OP/WONCA **Functional Health Assessment** (Nelson et al., 1987); General Health Status (SF-36);
- **Hospital admissions: Hospital Episode Statistics** (HES: Department of Health, Department of Health Statistics Section SD2 HES, 1998; Department of Health, 2004);
- **Mental health**: General Health Questionnaire (GHQ: Sterling, 2011)
- **Mental wellbeing**: 14-item Warwick Edinburgh Mental Wellbeing Scale (WEBWMS: Tennant et al., 2007); 7-item Short Warwick Edinburgh Mental Wellbeing Scale (SWEMWBS: Stewart-Brown et al., 2011);
- **Physical activity**: Timed Up and Go test (TUG: Podsiadlo & Richardson, 1991); Physical Activity Recall (PAR) and 7-day Physical Activity Recall scale (7-d PAR: Sallis & Saelens, 2000); Physical Activity Questionnaire (PAQ: Kriska & Caspersen, 1997);
- **Psychological wellbeing**: Hospital Anxiety and Depression Scale (HADS: Zigmond & Snaith, 1983);
- **Quality of life**: Delighted-Terrible Faces (DTFS: Andrews & Withey, 1976);

- **Social isolation**: Social Isolation (SI: Hughes, Waite, Hawkley, & Cacioppo, 2004); and
- **Social support**: Duke-UNC Functional Social Support Questionnaire (Broadhead, Gehlbach, De Gruy, & Kaplan, 1988).

The eight RCTs were split between:

- **Exercise Referral** with six studies
- **Arts on Prescription** and Supported referral with one study each.

Of the social prescribing schemes that employed qualitative and mixed methods studies:

- The largest number was for **Arts on Prescription**.
- Data collection across schemes consisted mainly of interviews (in-depth, semi-structured and follow-up), though focus groups; questionnaires (postal or phone); and surveys were also employed.
- Although the review focused on studies of patient data, some studies included interviews with GPs, other health practitioners and facilitators who also provided diary entries.
- Most methods of analysis comprised thematic analysis, with one study of Time Banks (Boyle, Clark, & Burns, 2006) carrying out interpretative phenomenological analysis.

Key outcomes of the reviewed studies revealed multiple benefits reported by participants and referrers directly engaged in social prescribing:

- Increases in **self-esteem and confidence, sense of control and empowerment**;
- Improvements in **psychological or mental well-being, and positive mood**;
- Reduction in **anxiety and/or depression, and negative mood**;
- Improvements in **physical health and lifestyle**;
- Reduction in **visits to general practitioners, referring health professionals and primary or secondary care services**;
- **Provision to general practitioners of a range of options to complement medical care** for a more holistic approach;
- Increases in **sociability, communication skills and social connections**;
- Reduction in **social isolation and loneliness, support for hard-to-reach people**;
- Improvements in **motivation and meaning in life providing hope and optimism**; and
- **Acquisition of learning, new interests and skills**.

Table 29. Social prescribing schemes with evaluation of primary research material (Chatterjee et al., 2018)

SP Scheme	Study	Intervention	Participants	Measures
Arts on Prescription	Crone et al. (2013)	Mixed methods study of 10-week arts programme "Art Lift" delivered in general practice surgeries or community facilities in Gloucestershire	Patients (*n* = 202) from differing socio-economic backgrounds referred through primary care for anxiety, depression, stress, low self-esteem, and chronic illness	Change in well-being on 14-item WEMWBS 7-item scale SWEMWBS; completion rates; observation and interviews
Arts on Prescription	Potter (2013)	RCT with wait- list controls: 12 weekly sessions over two phases across Cambridgeshire and Peterborough	Patients referred by primary care practitioners (*n* = 66) with mild to moderate anxiety and/or depression	Self-reported measures at baseline and 12-weeks: GAD-7; PHQ-9; WEMWBS; SI, plus analysis of semi-structured interviews
Arts on Prescription	Potter (2015)	Mixed methods, 12 weekly sessions in Cambridgeshire	Patients referred by primary care practitioners (*n* = 66) with mild to moderate anxiety and/or depression	Self-reported measures at baseline and 12-weeks: GAD-7; PHQ-9; WEMWBS; SI, plus analysis of semi-structured interviews
Arts on Prescription	2002)	Qualitative study: "East London Arts on Prescription", in Tower Hamlets, South Hackney, Newham, and Waltham Forest	Young men from African and Caribbean communities (*n* unknown) with mental health issues facing racism and discrimination	Interviews and consultation explored benefits of art and creativity in mental health promotion to develop alternative approaches to mental well-being
Arts on Prescription	Eades & Ager (2008)	Isle of Wight "Time Being" qualitative study of 12 weekly, creative sessions	Patients (*n* = 59) referred from primary care; follow-up patients (*n* = 22)	Interviews, focus groups, and pre-post questionnaires for depression, negative state, self-esteem, social anxiety, and ease of talking to people; plus 6-month follow-up
Arts on Prescription	Secker, Spandler, Hacking, Kent & Shenton (2007)	Retrospective quantitative analysis of Isle of Wight "Time Being" study	Patients from "Time Being" (*n* = 53) with mild-to moderate mental health issues	Interviews, focus groups, and pre-post questionnaires for depression, negative state, self-esteem, social anxiety, and ease of talking to people
Arts on Prescription	Stickley and Eades (2013)	Follow-up qualitative analysis two years after "Nottingham Arts on Prescription" scheme	Patients (*n* = 10) who were currently using or had previously used mental health services	Follow-up interviews conducted with participants two years after programme end
Arts on Prescription	Stickley and Hui (2012a)	Qualitative study used narrative enquiry	Participants currently or previously using	In-depth patient interviews conducted

		approach for 3-year programme (2008–2011)	mental health services (*n* = 16)	in community-based arts venues
Arts on Prescription	Stickley and Hui (2012b)	Qualitative study for above programme	Referrers (*n* = 10) from 148 who referred participants 2008–2011	In-depth semi-structured interviews
Arts on Prescription	White and Salamon (2010)	Mixed methods interim evaluation of 18-month "Arts for Wellbeing" pilot phase in County Durham consisting of six weekly sessions	Patients referred by GP practice (*n* = 220: 70 males and 150 females) aged 18–99 with physical and or mental ill-health; participants in focus groups (*n* = 6–10 per group)	Participant demographics; pre-post well-being measure: WEMWS (7- and 14-items), activity evaluation after six weeks; participant comments and narratives from six focus groups with 15 open-ended questions
Education on Prescription	Aylward & James (2002)	Qualitative study "Prescription for Learning" in Nottingham aimed to reduce dependency on health professionals	Patients (*n* = 196) referred by GPs, health visitors, practice and mental health nurses, for anxiety, low self-esteem and chronic pain; two-thirds had no academic qualifications and had not accessed learning since school	Semi-structured interviews with patients (*n* = 10) and health care professionals (*n* = 8)
Exercise on Prescription/Exercise Referral	Cock, Adams, Ibbetson, and Baugh (2006)	Pilot study trialled modified measure for evaluation of service quality	Patients attending exercise referral scheme (*n* = 627) referred through primary care	REFERQUAL questionnaire developed from SERVQUAL questionnaire
Exercise on Prescription/Exercise Referral	Crone, Johnston, Gidlow, Henley, and James (2008)	Study of patient uptake, initial progression, and completion of scheme over three years in Gloucestershire	Comparison of mental health (*n* = 134) and physical health (*n* = 2767) groups	Rates of uptake, initial progression, and completion as percentages
Exercise on Prescription/Exercise Referral	Dinan, Lenihan, Tenn, and Iliffe (2006)	Pilot study of two-phase progressive exercise programme with 14 London-based general practices	Patients (*n* = 158) aged 75+ deemed borderline frail by their GP or practice nurse	Timed Up and Go test (TUG) in seconds at baseline and programme end
Exercise on Prescription/Exercise Referral	Duda et al. (2014)	Cluster randomised controlled trial (RCT) compared 10–12-week exercise referral with or without Self Determination Theory (STD: Deci & Exercise on Prescription/Exercise Referral Ryan, 1985)	Patients (*n* = 347) referred by GP or practice nurse, randomly allocated to standard referral (*n* = 163) or STD group (*n* = 184)	Self-reported 7-day PAR at baseline, 3- and 6-month HADS and physiological measures
Exercise on Prescription/Exercise Referral	Edmunds, Ntoumanis, and Duda (2007)	Mixed methods study of individually tailored exercise programmes of 3-month duration grounded in STD	Overweight/obese patients (*n* = 49) referred by GP, aged 16–73 with coronary heart disease (CHD)	Self-report questionnaire at baseline, 1- and 3-months; rating scales for exercise behaviour,

		principles for primary care patients in the West Midlands	risk factors and body mass index (BMI) =38.75	motivation regulation, perceived autonomy and support, psychological need satisfaction and well-being; rated adherence (1–5 scale) of attendance
Exercise on Prescription/Exercise Referral	Flannery, Loughren, Baker, and Crone (2014)	Mixed methods study of 12-week programme of 30- minute sessions; general practices across South Gloucestershire	Patients (*n* = 2505: 987 m; 1518 f) aged 18–94 years; White British (95%); referred for BMI >30 and depression; patients with chronic illness (*n* = 312)	Self-reported pre-post WEMWBS; physiological measures; phone interviews with patients (*n* = 14) and practice nurses (*n* = 2); and cost analysis
Exercise on Prescription/Exercise Referral	Gidlow et al. (2007)	Doctoral research project, patients referred by health profession to exercise provision at leisure centres across several English counties	Participants (*n* = 3568) referred over 3 years (2000–2003) aged <92 years	Referral uptake 1+ session and completion 80+%; age, gender, rurality of location and level of deprivation as percentages of county population as a whole
Exercise on Prescription/Exercise Referral	Harrison et al. (2005)	RCT compared exercise referral plus written information with written information only for physical activity; single borough-based 12-month scheme in North West England	Primary care patients (*n* = 545) defined as sedentary by GP, randomly assigned to intervention or control group, stratified for gender, age and baseline CHD risk	Percentage of patients meeting physical activity target 90+ minutes per week of moderate/vigorous physical activity; 7-day PAR at 6- and 12-months
Exercise on Prescription/Exercise Referral	Isaacs et al. (2007)	RCT with three arms: effectiveness and cost-effectiveness of two, 10-week programmes of exercise (leisure centre or leisure instructor-led walking programme) or tailored advice-only, in outer London borough	Patients (*n* = 943) aged 70–94 years, not currently physically active with at least one CHD risk factor referred by GP	Comparison of three groups at baseline, 10 weeks, 6- and 12 months (control group randomised to intervention at 6 months) for percentage change in self-reported exercise, blood pressure, lipids, and cholesterol
Exercise on Prescription/Exercise Referral	James et al. (2009)	Longitudinal design over two years (2005–07) across five leisure centres in London borough offering individual and group sessions for up to 26 weeks	Patients (*n* = 1315) referred through primary care due to metabolic, orthopaedic, and cardiovascular conditions	Data recorded by exercise professional included: outcome completion, blood pressure reduction, and body mass reduction, with age, gender, ethnicity, occupation, and reason for referral
Exercise on Prescription/Exercise Referral	Lamb et al. (2002)	RCT compared community walking scheme plus advice on physical activity and cardiovascular health by	Participants (*n* = 260) aged 40–70 years taking <120 min moderate intensity activity per week,	Percentage of increased activity to >120 min per week at baseline, 6- and 12-months, and measures

		a health care professional, with advice-only controls	excluding those with recent illness	of aerobic capacity, BMI, blood pressure and cholesterol
Exercise on Prescription/Exercise Referral	Milton (2008)	University report on Eastern and Coastal Kent scheme, developed over 14 years; tailored 12-week twice-weekly programmes evaluated over three (2005–08)	Patients (*n* = 6541) <59 years referred by health professional for conditions including diabetes, hypertension, obesity, muscular-skeletal and mental health issues	Evaluation at baseline and 12-weeks: Demographics and physiological indicators plus qualitative component exploring patient attitudes towards physical behaviour
Exercise on Prescription/Exercise Referral	Munro et al. (2004)	Cluster RCT with 12 general practices across Sheffield not previously running exercise referral schemes (8 practices assigned to intervention group; 4 to control group); free, locally held exercise classes over three years	Patients (*n* = 6420) aged 65+ referred by GP excluding those with physical activity score in top 20%	SF-36 and PAQ for older adults at baseline, 2- and 3-years, with covariates of age, gender, smoking, whether living alone and hospital admissions <2 years prior to intervention; and instrumental cost per QALY
Exercise on Prescription/Exercise Referral	Murphy et al. (2012)	RCT "Wales National Exercise Referral Scheme", compared exercise intervention with normal care; and cost effectiveness of 16-week programme of twice-weekly, one-to-one or group exercise instruction	Sedentary patients (*n* = 2160) aged 16–88 referred by GP for CHD risk alone or mental ill-health alone (mild-to-moderate anxiety, depression, or stress) or for CHD risk and mental ill-health combined	Measures at baseline and 16 weeks using 7dPARS, HADS and EQ5D analysed on an intention to treat basis; follow-ups at 12 months using telephone and postal questionnaires
Healthy Living Initiatives	Dundee Healthy Living Initiative (2011)	Dundee Healthy Living Initiative promoted healthy eating, mental health and well-being, physical activity and smoking cessation	Participants (*n* = 1400) living in Dundee referred by health practitioner or self-referral	Surveys circulated to all participants compared attendance over three years (2011–14)
Social Prescribing	AgeUK (2011)	Quantitative study of Yorkshire and Humber scheme; offered social emotional, and practical support	Patients aged 55+ referred to AgeUK (*n* = 62) and other organisations (*n* = 34)	Smaller number older people (n unknown) completed WEMWBS at baseline and programme end
Social Prescribing	Brandling & House (2007)	Mixed methods study of "Refresh" community activities to complement medical care in Salford	Patients referred by GP practices (n unknown)	Patient interviews (n unknown) about frequency of GP visits and medication prescriptions
Social Prescribing	Brandling & House (2007)	Qualitative study in Keynsham near Bristol, referrals from three GP practices to local options	GP-referred patients (*n* = 11), general practice staff (*n* = 8), community stakeholders (*n* = 2)	Semi-structured interviews to explored acceptability of scheme as a non-clinical intervention
Social Prescribing	Dayson and Bashir (2014)	Quantitative evaluation of "Rotherham Social	Patients (*n* = 1607: 627 m; 980f), with	Well-being measures tool with eight areas

		Prescribing" pilot by Centre for Regional Economic and Social Research, Sheffield Hallam University, involving 29 GP practices	87% aged 60 and older referred by GP or Intensive Case Management team	designed for service, at baseline and after 3–4 months; HES mapped use of hospital resources over time including Accident and Emergency, outpatient appointments and admissions
Social Prescribing	Lovell and Bockler (2007)	Qualitative study of Sefton "North West Social Prescribing Development Project"	Patients with mild to moderate mental health issues (n unknown)	HADS; facilitator diary entries
Social Prescribing	Secker, Spandler, Hacking, Kent & Shenton (2007)	Qualitative study of Stockport "North West Social Prescribing Development Project"	Patients (*n* = 51: 24 for social functioning, 17 for depression and 10 for postnatal depression)	Review of patients' mental health; patient responses to two open-ended questions
Social Prescribing	South et al. (2008)	Case study of "Community Health Advice Team" (CHAT) by Bradford South and West Primary Care Trust (2005) with three general practices	Patients (223: 75 m; 148 f) aged 16+, through GP- or self-referral (tear-off slip on leaflet)	Semi-structured interviews with patients (*n* = 10), GPs (*n* = 3), practice managers (*n* = 2), practice nurses (*n* = 2) and healthy living centre co-ordinator (*n* = 1)
Social Prescribing	Woodall & South (2005)	Qualitative analysis of CHAT, pilot scheme in Bradford; including arts, crafts, and volunteering activities	Patients (*n* = 10) with non-clinical needs referred by general practices	18 semi-structured interviews with patients (*n* = 10) and health care staff (*n* = 8)
Supported Referral	Faulkner (2004)	Qualitative pilot study of "Patient Support Service" practice-based voluntary patient referral scheme in Doncaster	Patients being treated medically for psychosocial issues (*n* = 10) referred by GP; voluntary sector employed as advisors (*n* = 8) to link patients to community support	Semi-structured interviews and case studies with patients and volunteer advisors
Supported Referral	Grant et al. (2000)	RCT "Amalthea Project"; liaison organisation between primary care patients and voluntary organisations, in 26 general practices in county of Avon	Patients (*n* = 161) identified as having psychosocial issues by GP, randomly allocated to Amalthea Project (*n* = 90) plus routine GP care or routine GP care alone (*n* = 71)	Measures at baseline and 1- and 4-month follow-ups: HADS; Duke-UNC Functional Social Support Questionnaire; Dartmouth COOP/WONCA Functional Health Assessment, Delighted-Terrible Faces; economic evaluation of contact with primary care
Supported Referral	Howells2001)	Mixed methods study of 12-month programme in Swindon; offer included	Participants (n unknown) referred by	GHQ at baseline and 12 months; interviews with patients

		assisted access, coping skills training, support, and self-help literature	health professionals or self-referral	
Supported Referral	Sykes (2002)	Pilot study using qualitative methods in Penge and Anerley Park primary care practices	Participants (n unknown) experiencing psychosocial issues, signposted to services by health practitioners from GP practices	Interviews with patients and health care staff
Signposting/ Information Referral	Blastock, Brannelly, Davis & Howes (2005)	Qualitative study of "Signposting Project" of local services in North Staffordshire	Patients experiencing mental distress (*n* = 12) referred by general practice staff	Well-being questionnaires sent by post or conducted over the phone; phone interviews with practice staff
Signposting/ Information Referral	Phillips (2010)	Qualitative study of "Signpost" in Colchester and Tendring, Essex; offer included computing, job application, CV-writing and basic numeracy and literacy	Unemployed participants from deprived areas of Essex (*n* = 34) referred through Job Centre Plus	Online survey of participants, interviews with small number of managers, staff and volunteers; analysis of committee meeting minutes and business plan
Time Banks	Boyle et al. (2006)	Interpretative phenomenological analysis (IPA) of time banks in South East London, Gorbals in Glasgow, and Welsh Valleys	Local residents on three sites (*n* = 65) and staff (*n* = 41), co-ordinator training programmes for community action researchers	Interviews with residents; questionnaires and focus groups used to assess impact of co-productive time bank schemes

Pescheny et al., (2020) reviewed 16 social prescribing interventions including outcome measures and wellbeing metrics. Details for each study are given in Table 30. User outcomes of the SP programmes comprised the following identified themes: health and wellbeing, health-related behaviours, self-concepts and feelings, social interactions and day-to-day functioning.

The review found that the evaluation methodologies were variable in quality. Evidence for improvements in health and wellbeing, health-related behaviours, self-concepts and daily functioning were mixed- among quantitative studies this was attributed to the diversity of service user outcomes across studies. Positive outcomes on three scales, the *HADS, WEMWBS, and GHQ-12*, were identified. Conversely, *qualitative outcome measures were more consistent*. With one exception, the qualitative studies indicated that service users experienced improvements in health and wellbeing, self-concepts, feelings, health-related behaviours and day-to-day functioning, as well as reduced social isolation.

Table 30. Overview of studies included in the review (Pescheny et al., 2020)

Study	Context	Design	User outcomes
Brandling et al. (2011	New Routes, Keynsham Primary care professionals refer patients with social disengagement or low mood leading to a loss of connection to other people and the community, to a Social Prescribing navigator. Navigators assess patients' non-medical needs in a one-hour appointment and connect them with appropriate sources of support, provided by third sector organizations, to meet their needs.	Mixed methods study	Interviews with service users, navigators, referring general practitioners, and notes of navigators' reflective diaries 14-item Warwick Edinburgh Mental Wellbeing Scale (WEMWBS), Adopted Measure Yourself Medical Outcome Profile 2 (MYMOP2
Grayer et al. (2008)	GPCMHW Community Link scheme, London Boroughs of Camden and Islington Members of the primary health care team refer patients to graduate primary care mental health workers (GPCMHW) who carry out a semi-structures assessment of service user's psychosocial needs and advice service users about potential community resources which might help to meet their identified needs. The GPCMHW make the initial contact with the organizations and when required accompany service users to their initial meeting	Quantitative study: uncontrolled before and after study	Clinical Outcomes in Routine Evaluation – Outcome Measure (CORE-OM), General Health Questionnaire 12 (GHQ-12), Work and Social Adjustment Scale (WSAS)
Grant et al. (2000)	Amalthea Project, Avon General practitioners refer patients to a navigator who provides support and encourages attendance at recommended local and national voluntary organizations and support groups.	Quantitative study: randomized control trial	Hospital Anxiety and Depression scale (HADS), COOP/WONCA functional health assessment charts, Delighted-Terrible Faces Scale (Quality of life), Duke-UNC functional social support questionnaire
Carnes et al. (2017)	Social Prescribing Service, London Boroughs of City and Hackney General practitioners refer patients who were frequent attenders and/or socially isolated to a social prescribing navigator. At the first meeting with the navigator, service users discuss their personal circumstances and a mutually determined well-being action plan is developed. To achieve the goals on the action plan, service users are referred to community organizations and services. Volunteers are trained by the navigators to assist the delivery of the service and provide additional support to service users. Dayson et al. (2016) The Rotherham Social Prescribing service, Rothe	Mixed methods study	Interviews with service users Questionnaires for patients [including General Health score, HADS, wellbeing in the past week (0?6), active engagement in life score (0?20), number of regular activities (0?6)], number of medications prescribed (antidepressants, antipsychotics, anxiolytics, non-steroidal anti-inflammatory drugs and opioid analgesics)
Dayson et al. (2016)	Social Prescribing Service, London Boroughs of City and Hackney General practitioners refer patients who were frequent attenders and/or socially isolated to a social prescribing navigator. At the first meeting with the navigator, service users discuss their personal circumstances and a mutually determined well-being action plan is developed. To achieve the goals on the action plan, service users are referred to community organizations and services. Volunteers are trained by the navigators to assist the	Mixed methods study	Interviews with service users, public sector stakeholders, project staff, and voluntary and community organizations Rotherham wellbeing scale (consisting of eight measures associated with aspects of self-management: feeling positive, lifestyle, looking after yourself, managing

	delivery of the service and provide additional support to service users		symptoms, work, volunteering and other activities, money, where you live, and family and friends. For each measure a five point scale was used 1: Not thinking about it to 5: As good as it can be)
Farenden et al. (2015)	Community Navigation Programme, Brighton and Hove Mixed methods study Interviews with service users, general practitioners, and the practice manager General practitioners identify and refer patients with psychosocial needs to a navigator who assesses the psychosocial needs of patients and refers them to activities and services in the third sector. Once a service user is referred to an activity, the navigator follows-up the process, and if needed, offers further support.	Mixed methods study	Interviews with service users, general practitioners, and the practice manager Questions to measure enhanced wellbeing and quality of life (indicators: reduced isolation, increased social activity, community links, improvement in wellbeing)
Vogelpoel and Jarrold (2014)	Social Prescribing programme, Rotherham General practitioners identify and refer older patients who have single or multisensory impairment and experience social isolation and associated health problems to a navigator. The navigator contacts the service users and signpost them to a practical workshop programme. Transportation and communication needs are discussed at this stage. Regular contact is maintained with the navigator throughout the process, with reminders for transport arrangements and upcoming developments signposted to service users throughout the process.	Mixed methods study	Interviews with service users, family members, and staff (arts facilitators, support staff and resource centre manager) 14-item WEMBWS
Kimberlee et al. (2014)	Wellspring Healthy Living Centre's social prescribing wellbeing programme, Bristol General practitioners refer patients with psychosocial needs to a navigator. With the navigator's support, service users set health and wellbeing goals in an action plan. Navigators support service users to access sources of support in the community (e.g. peer-support groups, creative activities, physical activities) to achieve their health and wellbeing goals.	Mixed methods study	Interviews with service users, staff at the Wellbeing Healthy Living Centre, referring primary care professionals, funder of the intervention, community service manager, practice managers, social workers, mental health workers, city council officials Patient Health Questionnaire 9 (PHQ9) Scale for depression, Generalised Anxiety Disorder-7 (GAD7), Office for National Statistics (ONS) Wellbeing Scale (four indicators: satisfaction with life, feeling happy, feeling anxious, feeling doing worthwhile things in life), International Physical Activity Questionnaire (IPAQ), Friendship Scale for Isolation
Wigfield et al. (2015)	Fit for future programme, Nottinghamshire, Newcastle and West Cumbria	Mixed methods study	Interviews with referring general practitioners

	Primary healthcare professionals refer older patients with at least one long-term condition and declining health and/or mental wellbeing to a navigator of the social prescribing programme. The navigators develop an action plan with patients and refer them to sources of support in the community to meet their needs.		Seven-item Warwick Edinburgh Mental Wellbeing Scale (WEMWBS), question about fruit and vegetables consumption, questions about minutes walking per week and hard breathing activities, four indicators (companionship, feeling isolated, left out, in tune with others around) to measure social isolation and loneliness (no specified tool)
Moffat et al. (2017)	Link worker social prescribing programme, Newcastle upon Tyne Primary care professionals refer patients aged 40–74 years with one or more of the following long-term conditions: diabetes (types 1 and 2), chronic obstructive pulmonary disease, asthma, coronary heart disease, heart failure, epilepsy, osteoporosis, with or without anxiety or depression, to a navigator of the social prescribing programme. The navigators assess the psychosocial needs of the referred service users and jointly identify their health and wellness goals. Navigators connect service users to community and voluntary groups and activities (e.g. welfare rights advice, walking groups, physical activity classes, arts groups, continuing education) to help to achieve their goals.	Qualitative study	Interviews with service users
Loftus et al. (2017)	Social prescribing programme, Northern Ireland General practitioners refer patients over 65 years of age with a chronic condition (including falls, social isolation, depression/anxiety) and either evidence of polypharmacy (defined as five or more repeat medications) or viewed by the general practitioner as a frequent attender, to a social prescribing navigator. The navigator and the service user agree on a 12-week programme, including, e.g. social clubs, Men's Shed, counselling, arts programme, falls prevention, exercises classes, crochet classes, personal development, craft classes, befriending and computer courses, to improve the health and wellbeing of the service user.	Quantitative study: controlled before and after study (non-RCT	Number of prescribed medications
Friedli et al. (2012)	Sources of Support (SOS), Dundee General practice staff refers patients with psychosocial and/or practical support needs to a navigator. The navigators assess the psychosocial needs of patients and refer them to appropriate sources of support in the third sector, to meet their non-clinical needs.	Mixed methods study	Interviews with service users, referring primary care professionals, navigators 14-item WEMWBS, Work and Social Adjustment Scale (WSAS)
The Health Foundation (2015)	Shine, London Boroughs of City and Hackney General practice staff refers patients to a social prescribing navigator. The navigator assesses the service users' non-clinical needs and connects them with community services delivered by 85 statutory and voluntary groups.	Mixed methods study	Interviews with service users, navigators, referring general practitioners, community organizations, staff from City and Hackney Clinical Commissioning group Hospital Anxiety and Depression scale (HADS),

			General Health Score (tool not specified, General Wellbeing Scale (tool not specified), Positive and active engagement in life (tool not specified)
ERS Research and Consultancy (2013)	Newcastle Social Prescribing project, Newcastle Healthcare professionals refer patients with psychosocial needs to one of the five collaborating Linkwork Organizations (Age UK, HealthWorks, Newcastle Carers, Search and West End Befrienders). Navigators from the Linkwork Organization assess the non-clinical needs of referred service users and either refer them to activities provided by their organization or refer them to other activities in the third sector to meet their non-clinical needs.	Mixed methods study	Interviews with service users, referring healthcare practitioners, steering group members Seven-item Warwick Edinburgh Mental Wellbeing Scale (WEMWBS), Confidence scale (Unspecified tool)
Baines (2015)	Rugby Social Prescribing Project, Warwickshire General practitioners refer patients who had experienced a recent change in their circumstances, such as a diagnosis of a chronic condition or bereavement, to a navigator. The navigator assess the patient's non-clinical needs and signpost them to sources of support in the community		Interviews with social prescribing staff, project partners, and service users 14-item WEMWBS
Age UK (2012)	Social Prescribing, Yorkshire and Humber General practitioners refer patients aged 55 years or older who have mild to moderate depression or were lonely and socially isolated to a navigator based on a local Age UK side. The navigator completes an in-depth assessment of the service users' social, emotional and practical support needs. Service users are then signposted to Age UK services to meet their identified non-clinical needs.		Qualitative data collection methods are not stated in the report Qualitative data collection methods are not stated in the report

Bickerdike et al., (2014) reviewed 14 social prescribing interventions that used the following wellbeing evaluation metrics:

- Warwick Edinburgh Mental Well-being Scale (WEMWBS).
- Hospital Anxiety and Depression Scale (HADS).
- General Anxiety Disorder-7 (GAD-7).
- Patient Health Questionnaire-9 (PHQ-9).
- Clinical Outcomes in Routine Evaluation-Outcome Measure (CORE-OM).
- Work and Social Adjustment Scale (WSAS).
- General Health Questionnaire (GHQ-12).
- COOP/ WONCA.

The reviewers commented that it was difficult to quantify the size of the observed improvements (due to a lack of reported detail, a lack of sufficient control group data and differences in reporting between studies). It was not possible to determine whether any observed improvements were clinically significant. Studies reported

short-term outcomes only; there was no evidence about the effect social prescribing has on health and well-being outcomes beyond 6 months.

One uncontrolled before and after study used a bespoke measure, the Wellspring Well-being Questionnaire, comprising PHQ-9 and GAD-7 tools, and items from Office of National Statistics (ONS's) Well-being Index/ Integrated Household Survey and International Physical Activity Questionnaires. A second also used a bespoke measure which used a 5-point scale across eight domains associated with different aspects of self-management such as 'looking after yourself' and 'managing symptoms'. Two further descriptive reports also indicated they used the WEMWBS to measure changes in health and wellbeing but were poor reported and involve what appear to be very small numbers of respondents. In the two studies using non-validated measures, some positive improvements in outcomes such as depression and anxiety at 3– 4 months' follow-up were reported.

With specific reference to vulnerable populations, though not exclusively diet-related, Campbell et al., (2021) reviewed 26 articles in which 16 empowerment measurement tools were developed, validated/translated, or used. There were significant gaps in empowerment tool measurement, development and evaluation processes. In particular, the results suggest that in addition to systematic assessments of psychometric properties, the inclusion of feasibility and clinical utility as outcome measures are important to assess relevance to clinical practice. Wellbeing (empowerment) outcome measures are displayed in Table 31.

Table 31. Characteristics of the empowerment measurement adopted in the review (Campbell et al., 2021)

Author	**Aim**	**Measure**	**Domains of empowerment**
Anderson, Funnell	To evaluate the effectiveness of a problem-based empowerment patient education program targeting urban African Americans with type 2 diabetes	Diabetes Empowerment Scale Short-Form (DESSF	8 domains: 1) assessing the need for change 2) developing a plan 3) overcoming barriers 4) asking for support 5) supporting oneself 6) coping with emotion 7) motivating oneself; 8) making diabetes care choices appropriate for one's priorities and circumstances
Bhatta and Liabsuetrakul	To assess effectiveness of an empowerment intervention to HIV infected people receiving prevention and antiretroviral therapy	Empowerment Scale	5 domains: 1)self-efficacy/ self-esteem 2)power-power-lessness 3) com- munity activism and autonomy 4) optimism and control over the future 5) righteous anger

Blanchard, Mohan	To assess effectiveness of empowerment program for HIV prevention among female sex workers	Empowerment survey	3 domains: 1) power with: a sense of individual self-esteem and confidence 2) power within: collective identity and solidarity 3) power over: reflects access to social entitlements
Borghei, Taghipour	To development and validation of a new tool to measure Iranian pregnant women's empowerment	Self-Structured Pregnancy Empowerment Questionnaire	3 domains: 1) educational empowerment 2) autonomy 3)socio-political empowerment
Cheung, Mok	To examines the relationship between personal empowerment and life satisfaction among self-help group members	Personal empowerment Scale	3 domains: 1) intrapersonal empowerment 2) interpersonal empowerment 3) extrapersonal empowerment
Contreras-Yáñez, Ruiz-Medrano	To adapt the Spanish version of the Health Empowerment Scale (S-HES) in RA patients from Latin American	RA Empowerment Scale for Hispanic patients (RAEH)	8 domains: 1) satisfaction and dissatisfaction related to health 2) identification and achievement of personally meaningful goals 3) application of a systematic problem-solving process 4) coping with the emotional aspects of living with health 5) stress management 6) appropriate social support 7) self-motivation 8) making cost/ benefit decisions about making behaviour changes
Corrigan	To assess relation- ship between participation in consumer operated services and measures of recovery and empowerment in people with psychiatric disability		5 domains: 1) self-efficacy/ self-esteem 2) power-power- lessness 3) com-munity activism and autonomy 4) optimism and control over the future 5) righteous anger
Dempsey and Dunst	To investigate how help-giving practices operate to produce variations in family empowerment	Family Empowerment Scale (FES)	2 domains: 1) level of empowerment (individual, service and community) 2) expression of empowerment (attitude, knowledge and behaviour)
Diamond-Smith, Treleaven	To explore whether measures of women's empowerment are associated with their experiences of mistreatment at their last childbirth	Gender Equitable Men scale	4 domains: 1)violence 2) sexual relation- ships 3) reproductive health and dis-ease prevention 4) domestic chores and daily life
Farber and Maha- raj	To evaluate effectiveness of a group-based education curriculum empowerment program on high-risk African American families with children with developmental delays	Shortened Family Empowerment Scale (FES)	2 domains: 1) level of empowerment (individual, service and community) 2) expression of empowerment (attitude, knowledge and behaviour)
Godoy, Patel	To explore nutritional status and spousal empowerment among native Amazonians	Individual empowerment survey	2 domains: 1)Decider 2) tie breaker

Hansson and Björkman	To assess reliability and validity of the Swedish version of an empowerment scale in people with a mental illness	Making Decisions scale	5 domains: 1) self-efficacy/ self-esteem 2) power-power-lessness 3) com- munity activism and autonomy 4) optimism and control over the future 5) righteous anger
Haswell, Kavanagh	To validate psychometric properties of the Growth and Empowerment Measure (GEM) in Indigenous Australians	Growth and Empowerment Measure (GEM)	2 domains: 1) Emotional Empowerment Scale (EES) (Self-capacity; Inner Peace) 2) 12S (Healing and Enabling Growth, Connection and Purpose
Homko, Sivan	To examine the effect of self-monitoring blood glucose on feelings of self-efficacy in women with gestational diabetics	Diabetes Empowerment scale	5 domains: 1) setting goals 2) solving problems 3) obtaining sup- port 4) motivating oneself 5) making decisions
Jersky, Titmuss	To evaluate effectiveness an urban art-based community health program on improving health service access and wellbeing of young Aboriginal parents	Growth and Empowerment Measure (GEM)	2 domains: 1) Emotional Empowerment Scale (EES) (Self Capacity; Inner Peace) 2) 10S (Healing and Enabling Growth, Connection and Purpose)
Kaczinski, Rosen- heck	To assess psycho- metric property of empowerment and confidence among veterans with psychiatric disabilities	Empowerment Scale	5 domains: 1) self-efficacy/ self-esteem 2)power-power-lessness 3) com- munity activism and autonomy 4) optimism and control over the future 5) righteous anger
Kameda and Shimada	To develop an empowerment scale for pregnant women	Empowerment Scale for pregnant women	5 domains: 1) self-efficacy 2) future image 3)self-esteem 4) support and assurance from others 5) joy of an addition to the family
Klima, Vonderheid	To develop a Pregnancy-related Empowerment Scale and adapted in Spanish-speaking population	Pregnancy Related Empowerment Scale (PRES)	4 domains: 1) provider connectedness 2) skilful decision-making 3) peer Connectedness 4) gaining voice
Koren, DeChillo	To measure empowerment in families with children having emotional dis- abilities	Family Empowerment Scale (FES)	3 domains: 1)Family 2) service system 3)community/ political
LoGiudice, Josif	To describe demographic features and wellbeing of carers of Aboriginal Australians	Growth and Empowerment Measure (GEM)	2 domains: 1) Emotional Empowerment Scale (EES) (Self Capacity; Inner Peace) 2) Core 6 (Healing and Enabling Growth, Connection and Purpose
Patil, Klima	To investigate how antenatal care affects aspects of women's sense of control over their pregnancy	Pregnancy Related Empowerment Scale (PRES)	4 domains: 1) provider connectedness 2) skilful decision-making 3) peer Connectedness 4) gaining voice
Nishita, Cardazone	To examine effectiveness of empowerment program: life coaching and pharmacist counselling for employed adults with diabetes	Diabetes Empowerment Scale Short-Form (DESSF)	8 domains: 1) assessing the need for change 2) developing a plan 3) overcoming barriers 4) asking for support 5) supporting oneself 6) coping

			with emotion 7) motivating oneself; 8) making diabetes care choices appropriate for one's priorities and circumstances
Yamada and Suzuki	To assess the levels of empowerment in Japanese patients with chronic schizophrenia	Empowerment Scale-J	5 domains: 1) self-efficacy/ self-esteem 2) power-power-lessness 3) com- munity activism and autonomy 4) optimism and control over the future 5) righteous anger
Castelein, van der Gaag	To compare three instruments that are used to measure empowerment of people with psychotic disorders	Empowerment Scale (ES); the Personal Empowerment Scale (PES); the Mental Health Confidence Scale (MHCS)	ES 5 domains: 1) self-efficacy/ self-esteem 2)power-power- lessness 3) com- munity activism and autonomy 4) optimism and control over the future 5) righteous anger PES 2 domains: 1)discretion 2) reduction in chance MHCS 3 domains: 1)optimism 2) coping 3) advocacy
Bovill, Bar-Zeev	To pilot the Growth and Empowerment Measure (GEM) with a sample of pregnant Aboriginal women who smoke	Growth and Empowerment Measure (GEM)	2 domains: 1) Emotional Empowerment Scale (EES) (Self Capacity; Inner Peace) 2) Core 6 (Healing and Enabling Growth, Connection and Purpose
Berry, Crowe	To examines the sensitivity to change of the new Growth and Empowerment Measure (GEM) for Indigenous Australians in Substance Abuse Treatment	Growth and Empowerment Measure (GEM)	2domains: 1) Emotional Empowerment Scale (EES) (Self Capacity; Inner Peace) 2) Core 6 (Healing and Enabling Growth, Connection and Purpose

In conclusion, interventions have employed a range of anthropometric, biomarker, and self-report health/quality of life metrics to assess physical and mental health/well-being outcomes among intervention participants. A multidimensional approach to wellbeing encompassing objective physiological measures and subjective assessments of mental health and quality of life would enable a comprehensive evaluation of their effectiveness in promoting overall health and well-being within community settings. To complete this section, Table 32 presents various toolkits and resources of relevance to physical and mental wellbeing and quality of life metrics.

Table 32. Resources and toolkits for health and wellbeing change measures and metrics

Source	Description	Link
Association of UK Dieticians Dietetic Outcomes Toolkit	This document is a practical toolkit to collectively capture the tools available with the aim of facilitating the adoption of outcome data collection. The BDA Model and Process describes, through the six steps, the consistent process dietitians follow in any intervention. The BDA Outcomes Framework aligns with some of the steps of the Model and Process and includes standardised language for many of these steps to enable consistent recording and monitoring of outcome data. DOT provides example tools that could be used as goal/outcome indicators (a measure of whether the goals/outcomes have been achieved).	dietetic-outcomes-toolkit-updated-march-2021.pdf (peng.org.uk)
NHS, Green Social Prescribing Toolkit:	This toolkit is specifically about the learning that has arisen from the targeted Green Social Prescribing programme to tackle and prevent mental ill-health. It is anticipated that a lot of the learning and practice arising from the targeted mental health programme will be relevant to applying green social prescribing to address other priorities and to support people with other major conditions.	nhs-green-social-prescribing-toolkit.pdf (socialprescribingacademy.org.uk)
University of Essex, Toolkit for Social Prescribing: Lessons and Recommendations from a Cross-Sectoral International Social Prescribing Project:	This Toolkit has been created to offer guidelines as to how a social prescribing programme can be designed, managed, delivered, and evaluated. It is meant to be a resource for those looking to implement a social prescribing programme locally or in coordination across different localities. The guidance offered here can serve as a reference point for individuals and organisations across a wide range of social prescribing services and communities. It should be useful to those considering adopting social prescribing, as well as those already delivering, and even those reflecting on programmes that have ended.	Microsoft Word - Toolkit English v9.docx (essex.ac.uk)
UK Government, Social prescribing: applying All Our Health:	This guide will help frontline health and care staff use their trusted relationships with patients, families and communities to promote the benefits of social prescribing.	Social prescribing: applying All Our Health - GOV.UK (www.gov.uk)
National Academy for Social Prescribing, How to use social prescribing to support Population Health Management A guide for Integrated Care Systems:	This guide is intended to support Integrated Care Systems in their approach to PHM, with social prescribing case studies, tips, questions to consider and more	How to use social prescribing to support Population Health Management - a guide for Integrated Care Systems | NASP (socialprescribingacademy.org.uk)
National Academy for Social Prescribing, Green Social Prescribing Advocacy:	As part of the Green Social Prescribing Programme to Tackle and Prevent Mental Ill-health, this advocacy pack is designed to help individuals in a position of influence to help others understand the value Green Social Prescribing	Green Social Prescribing - what you need to know from the National Academy for Social Prescribing | NASP (socialprescribingacademy.org.uk)
National Academy for Social Prescribing, Green	In July 2020, Environment Secretary George Eustice announced a £5.77 million investment for a cross-government Green Social Prescribing project, funded by Treasury and core partners, aimed at preventing and tackling mental ill health through green social	Green Social Prescribing Practice Report - National Academy for Social Prescribing | NASP (socialprescribingacademy.org.uk)

Social Prescribing Practice Report:	prescribing. The aim of the two-year project was to test how to embed green social prescribing into communities in order to: improve mental health outcomes: reduce health inequalities: improve connectivity with the health system in order to reduce demand on the health and social care system: develop best practice in making green social activities more resilient and accessible. The 'test and learn' phase of the funded Green Social Prescribing Project ran from April 2021 to the end of March 2023. During this time, over 8,500 people benefited from green social prescribing. This practice report shares some of the key learning from practice that took place during the test and learn programme, in the seven test and learn sites.	
National Academy for Social Prescribing, Addressing health inequalities in Slough through social prescribing:	Dr Priya Kumar, GP and Health Inequalities Lead for Slough and Transformational Clinical Lead for the Connected Care programme at Frimley ICB, explains how social prescribing link workers in the area have taken a lead in finding out about and responding to the needs of the population. Key lessons from this case study: Identified residents who may have unmet health needs through a population health management approach, and proactively engaged with them: Embedded the new social prescribing workforce within the primary care infrastructure: Built the relationship between primary care and the wider support in the system, including the voluntary sector, housing, citizen bureau, drugs and alcohol, mental health services: Identified the potential linked outcomes in health from a social prescribing intervention.	Addressing health inequalities through social prescribing - National Academy for Social Prescribing | NASP (socialprescribingacademy.org.uk)
National Academy for Social Prescribing, NHS Green Social Prescribing Toolkit:	This toolkit is specifically about the learning that has arisen from the targeted Green Social Prescribing programme to tackle and prevent mental ill-health. It is anticipated that a lot of the learning and practice arising from the targeted mental health programme will be relevant to applying green social prescribing to address other priorities and to support people with other major conditions. The purpose of the toolkit is to offer a 'how to' guide for those people who have responsibility for, or a role in, starting, developing, or growing green social prescribing schemes.	nhs-green-social-prescribing-toolkit.pdf (socialprescribingacademy.org.uk)
National Academy for Social Prescribing, measuring outcomes for individuals receiving support through social prescribing:	This evidence summary is one of a suite commissioned by the National Academy for Social Prescribing (NASP) from their Academic Partners in 2021 https://socialprescribingacademy.org.uk/evidence-on-social-prescribing/our academic-partners/). The topics included in this suite were identified through a robust prioritisation process with individuals representing the breadth of the social prescribing landscape. The summaries were produced by researchers from the NASP Academic Partnership; specific teams are listed on each document.	evidence-review-measuring-impact-and-outcomes-for-social-prescribing.pdf (socialprescribingacademy.org.uk)
NHS England Green Social Prescribing:	Range of resources on green social prescribing. Green social prescribing is the practice of supporting people to engage in nature-based interventions and activities to improve their mental and physical health. Social prescribing link workers (and other trusted professionals in allied roles) connect people to community groups and agencies for practical and emotional support, based on a 'what matters to you' conversation. Green social prescribing includes both what is known as green and blue activities. These could include local walking schemes, community	NHS England » Green social prescribing

	gardening projects, conservation volunteering, green gyms, open water swimming or arts and cultural activities which take place outdoors. These activities may be 'prescribed' by link workers (and other trusted professionals) alongside other forms of support, for example, referrals to support for housing or finances – based on the needs and circumstances of each individual.	
University of Edinburgh, Development of a Toolkit for Green Social Prescribing:	We are running a project to design a "digital toolkit" or online resource that can help improve access to "Green social prescribing" for people over the age of 50 who are living in deprived areas.	Green Social Prescribing | The University of Edinburgh
NHS England, Social prescribing and community-based support: Summary guide:	The Social Prescribing Summary Guide is intended for people and organisations leading local implementation of social prescribing. It enables: 1. increased understanding of what good social prescribing looks like and why social prescribing improves outcomes and experiences for people, their families and carers, as well as achieving more value from the system: 2. commissioning of local social prescribing connector schemes, enabling all general practices, local authorities and other agencies to refer people with wider social needs to community-based support: 3. collaborative working amongst all local partners at a 'place-based' local level, to recognise the value of community groups and assets and to enable people to build or rebuild friendships, community connections and a sense of belonging, as well as accessing existing services.	NHS England » Social prescribing and community-based support: Summary guide
UK Government, Social prescribing: applying All Our Health:	This guide will help frontline health and care staff use their trusted relationships with patients, families and communities to promote the benefits of social prescribing. Introduction: Access the social prescribing e-learning session: Social prescribing: Promoting social prescribing in your professional practice: Core principles for healthcare professionals: Taking action: Understanding local needs: Measuring impact: Further reading, resources and good practice	Social prescribing: applying All Our Health - GOV.UK (www.gov.uk)
NHS England, Social prescribing: Reference guide and technical annex for primary care networks:	This guide provides additional information to help PCNs introduce the social prescribing link worker role into their multi-disciplinary teams (MDTs) as part of the expansion of the primary care workforce introduced through the Network Contract Directed Enhanced Service (DES) 22/23 Additional Roles Reimbursement Scheme. It also provides information to deliver the proactive social prescribing element of the Network Contract DES Personalised Care service specification.	NHS England » Social prescribing: Reference guide and technical annex for primary care networks

5.0. Carbon emission reduction measures and metrics

5.1. Introduction

Assessing changes in carbon emissions associated with dietary behaviours has utilised various metrics and methodologies providing insights into intervention outcomes and informing strategies for mitigating environmental impacts within community settings. Carbon footprint calculators are interactive tools that allow individuals or households to estimate their carbon emissions based on their consumption patterns and lifestyle choices. These calculators typically consider emissions associated with food consumption and waste generation, providing users with personalised feedback on their environmental impact.

5.2. Review of the evidence for carbon emissions from diet and food measures and metrics

From research into food waste and sustainability, Gardner et al., (2023) conducted a scoping narrative review of education-based food waste interventions, which are summarised in Table 33.

Of studies using quantitative or mixed methods (n = 20), a range of study designs was identified, the most common being a pre–post design without a control group comparator. 5 were modelling studies, 3 used a pre–post design with a comparator, 2 used a cross-over design, 2 used a historical control and 1 used a cluster randomised trial design. The studies that used qualitative methods only differed in their approach, with one undertaking focus groups only, one conducting semi-structured interviews only, 1 using an action research approach and another using interviews, focus groups and observation with a case study design.

Table 33. Characteristics of school lunch menu interventions included for review (Gardner et al., 2022)

Study	**Evaluation design**	**Outcome(s) Related to Sustainable School Food Systems**
Poinsot et al., 2022	Pre–post (Modelling study)	Greenhouse gas emissions (% reduction in kg CO2 eq per meal)
Colombo et al., 2021	Qualitative study: Focus groups (n = 9)	Barriers and levers to successful implementation of sustainable menu
Perez-Neira et al., 2021	Pre–post (Modelling study)	Total GHG emission (% reduction in kg of CO2 -eq per meal)
Batlle-Bayer et al., 2021	Pre–post (Modelling study)	% reduction in environmental impact (based on Nexus approach measures)

Colombo et al., 2020	Pre–post	(1) Food waste (g/pupil); (2) Consumption (g/pupil); (3) School meal satisfaction (pre-post questionnaire).
Blondin et al., 2022	Pre–post	(1) GHG emissions kg CO2 -eq (per entree offered on a Monday and per entree averaged over week); (2) Water resources (litres).
Elinder et al., 2020	Pre–post	1) Food consumption (g/pupil); (2) Food waste (g/pupil).
Martinez et al., 2020	Pre–post (Modelling study)	Carbon footprint (kg CO2 eq.person/monthly)
Hamerschlag & Kraus-Polk 2017	Pre–post	(1) Reduction in meat/dairy (lb per meal/%); (2) Greenhouse gas emissions (kg CO2 -eq per meal served); (3) Water footprint (gallons per meal); (4) Cost saving ($/%)
Ribal et al., 2016	Pre–post (Modelling study)	Carbon footprint (kg CO2 equivalent)
Thorsen et al., 2015	Cluster randomised controlled unblinded cross over study	(1) Food intake (g); (2) Edible waste (g/%).
Lombardini et al., 2013	Pre–post with comparator	(1) Participation in school lunch (%); (2) Food taken (g); (3) Food waste (g).
Orme et al., 2010	Pre–post	Number of schools using local suppliers (%)
Boulet et al., 2022	Pre–post	(1) Food waste (overall number of avoidable food waste items in packed lunch); (2) Self report eating of 'all' food at school (%); (3) Parental attitudes (qualitative methods).
Vidal-Mones et al., 2022	Pre–post	Total food waste (kg)
Malefors et al., 2022	Pre–post with comparator	Food waste for each strategy tested (g)
Rigal et al., 2022	Cross-over trial with repeated measures: T1 (baseline), T2 (T1 + 21 days)	Food waste (g)
Anton-Peset et al., 2021	Pre–post with comparator	(1) Food waste (g/%); (2) Knowledge and attitudes: pre–post survey and qualitative methods
Elnakib et al., 2021	Pre–post	(1) Number of strategies implemented in each school (Mean and range); (2) Food waste (%).
Lochner et al., 2021	Semi structured interviews	Perceived learning outcomes of VGCE
Ferguson et al., 2019	Qualitative active research (survey, self-evaluation, reflection, journals and interviews).	Understanding of concepts described in the training and whether they influenced teaching practice.
Cramer et al., 2019	Qualitative case study (interviews, focus groups and observations)	Perceived efficacy of school garden programme for food system 'reskilling'.
Goldberg et al., 2015	Cluster RCT	Mean prevalence of single use packaging (%).
Jones et al., 2012	Historical control	Positive attitude towards sustainable food (%).

Dreijerink & Paradies (2020) systematically reviewed 12 studies measuring the effect of carbon footprint calculators on awareness and behaviour within the field of health psychology and health related interventions looking at how to improve footprint calculators to become more effective in changing behaviour . Outcome measures for included studies are shown in Table 3. The authors made the following conclusions:

— Effects of carbon footprint calculators on behaviour vary.
— Carbon footprint calculators can benefit from including additional behaviour change techniques.
— Carbon footprint calculators should be used as part of a national communication plan.
— Carbon footprint calculators should be integrated with broader interventions.

Table 34. Description of reviewed studies: authors, description of the calculator, the design of the study and the found effects (Dreijerink & Paradies, 2020)

Authors	**Description of the calculator**	**Target group**	**Method Effects**
Aichholzer et al. (2012)	Online and offline carbon calculator (e2democracy tool) on: Energy supply (electricity and heating), mobility, nutrition, consumption. Self-report.	Calculator users (n=222) in Germany, Austria. Survey in combination with data collection in calculator over two-year period. Questions on awareness, knowledge, effort and behavior	Awareness was raised. Footprints were smaller.
Büchs et al. (2018)	Carbon calculator interview on: heating, lighting, appliances, car travel, other surface travel, air travel and household goods. Self-report and energy bill	Households (n=218) in South-Hampton, UK Field experiment (RCT) with test group (n=95) and control group (n=123). Eight surveys over two-year period. Questions on attitudes and behaviours	Awareness was raised. Footprints were not smaller.
Chatterton et al. (2009)	Carbon calculators in general, no specific type. On; various categories, main focus on transport. Self-report.	Explorative study. Expert interviews (n=8) on good practices for communicating environmental information. Carbon calculator user interviews (n=20), on accessibility and usability. 15 focus groups (n=8-10) with non-users of carbon calculators	Not an effect study.
Gram-Hanssen and Christensen (2012)	Map my Climate website on: heat, electricity, automobile transportation, non-food commodities, air travel, use of second home, and food. Self-report.	Calculator users (n=220) Questionnaires on use of website, how it had influenced them, attitudes and knowledge about climate change, everyday behavior before the visit. Q2 on change filled in by n=99 (two weeks later). Three focus groups (n=18) on website content.	Awareness was raised. Footprints were not smaller
Hunter et al. (2006)	Diary recordings in a spreadsheet EF calculator (Wackernagel et al. 2000) On: food/drink, goods, transport and waste. Self-report. Housing estimated from	UK households (n=28) in Aberdeen, Scotland Interviews, preliminary questionnaire, a two week diary-recording period. Diary recordings were entered in a spreadsheet EF calculator.	Awareness was raised. Behavior change was not measured.

	secondary data (meter readings)		
Laakso and Lettenmeier (2016)	Material Input Per unit of Service (MIPS); Household-level Sustainability Transition methodology (HST). On: Housing and nutrition (wk 1), household goods and leisure time activities (wk 2) and mobility and tourism (wk 3). Self-reported.	Households (n=5) in Jyväskylä, Finland, Based on first questionnaire material footprints were calculated. Co-creation workshop to develop household-specific visions in roadmaps. 4-week experiment with self-chosen ideas from roadmap. Final future workshop with participants and stakeholders.	Awareness was raised. Footprints were smaller
Lin (2016)	PErsonal CArbon FOotprint Management System (PECAFOMS) on: campus activities, family life, water resource, transport, waste disposal, and waste recycling. Self-report.	Taiwanese high school students (n=66) Quasi-experiment. Two groups: simple footprint calculator 4 times (n=33) vs. PECAFOMS six times (n=33). Pretest and post-test questionnaire on determinants of environmental behavior and behavior	Awareness was raised. Footprints were smaller for the simple calculator.
Lin (2017)	PECAFOMS on: campus activities, family life, water resource, transport use, waste disposal, and waste recycling. Self-reported.	Taiwanese students (n=279). Questionnaire on beliefs, attitudes, intentions, personal norms and continuance intention	Not an effect study.
Mallett et al., (2013)	Manipulated carbon feedback on: Transportation, housing, spending habits. Self-report.	US Students (n=152) urban Midwest Computer experiment	Experience of more guilt, and higher willingness to volunteer
Salo et al. (2019)	Baltic Sea Card, Car comparison calculator, Climate Neutral Now, CO2-beregneren, Ducky, Ilmastodieetti, Klimatkontot, Kolvidur calculator, Min klimatpåverkan (REAP Petit in UK), WWF UK environmental carbon footprint	Evaluation of 10 footprint calculators in Nordic countries on characteristics (opportunities/ limitations). Interviews with six calculator hosts on expectations and experiences.	Not an effect study.
Sutcliffe et al. (2008)	Ecological Footprint Analysis (EFA) on: food, energy, transport, house and garden size, waste production and consumer spending. Self-report.	UK households (n=18). Four questionnaires on awareness, attitudes and behavior. After Q2 a mini report with feedback and tips.	Footprints were reduced.
West et al. (2016)	REAP Petite footprint calculator	Users in UK (n=28) and Sweden (n=21) Residents meetings and interviews on use of calculator.	Not an effect study.

Kim & Neff (2009) reviewed the fitness of selected carbon calculators for measuring and communicating indirect GHG emissions from food consumption, based on the

scope of user behaviours accounted for, data sources, transparency of methods, consistency with prior data and effectiveness of communication. They found food consumption was under-represented (25%) among general environmental impact calculators (*n* = 83) and identified 8 carbon calculators that accounted for food consumption (that included U.S. users among the target audience). Among these, meat and dairy consumption was appropriately highlighted as the primary diet-related contributor to emissions.

They conclude that opportunities exist to improve upon these tools, including:

- Expanding the scope of behaviours included under calculations.
- Improving communication, in part by emphasizing the ecological and public health co-benefits of less emissions-intensive diets.
- Adopting more robust, transparent methodologies, particularly where calculators produce questionable emissions estimates.
- All calculators could benefit from more comprehensive data on the U.S. food system.

These advancements may better equip these tools for effectively guiding audiences toward ecologically responsible dietary choices. Details of the reviewed measures appear in Table 35.

Table 35. Features of reviewed carbon calculators (Kim & Neff, 2009)

Developer, (most recent date of update), *title*	Food type: Meat/dairy	Food type: Other foods	Mode of production: Organic	Mode of production: Local	Mode of production: In season
The Berkeley Institute of the Environment (BIE) (2008) *CoolClimate Carbon Footprint Calculator*[62]	Spending	Spending			
Bon Appétit Management Company Foundation (Bon Appétit) (2008) *Low Carbon Diet Calculator*[63]	Quantity	Quantity		Quantity (fish only)	Quantity
Carbon Footprint (2008) *Carbon Footprint Calculator*[64]	Dietary lifestyle		Frequency	Frequency	Frequency
Carbonify.com (n.d.) *Carbon Dioxide Emissions Calculator*[65]	Dietary lifestyle				
Clearwater (2005) *Clearwater Carbon Calculator*[66]			Spending		

[62] http://coolclimate.berkeley.edu/
[63] http://www.eatlowcarbon.org/
[64] http://www.carbonfootprint.com/calculator.aspx
[65] http://www.carbonify.com/carbon-calculator.htm
[66] http://www.clearwater.org/carbon.html

Conservation International (2008) *Carbon Calculator*[67]	Dietary lifestyle				
The Nature Conservancy (2008) *Carbon Footprint Calculator*[68]	Dietary lifestyle		Frequency		
Stop Global Warming (2008) *Carbon Calculator*[69]			Frequency	Frequency	

In summary, community diet interventions have adopted a range of metrics and methodologies to evaluate changes in carbon emissions associated with participants' dietary behaviours. By utilising approaches such as life cycle assessment and carbon footprint metrics, these interventions enable comprehensive evaluations of their environmental sustainability impact and provide insights into strategies for promoting low-carbon dietary practices within community settings. Finally, toolkits and resources of relevance to carbon measures and metrics through diet and food-related practice change are compiled in Table 36.

Table 36. Resources and toolkits for dietary and food-related carbon emissions measures and metrics

Source	**Description**	**Link**
Greener Practice Network, Greener impact for health: A practical toolkit for greener general practice – 2/10/20	This webinar launched version 7 (2020/21) of the Green Impact for Health (GIFH) toolkit. This free toolkit provides detailed guidance on specific practical actions that GP Practices can take towards environmentally sustainable practice.	Greener impact for health: A practical toolkit for greener general practice – 2/10/20 – Greener Practice
Association of UK Dieticians, One Blue Dot: Environmentally sustainable diets toolkit:	One Blue Dot is the BDA's Environmentally Sustainable Diet Project, created to help make our Sustainable Diets Policy a reality. On these pages you will find a toolkit of information, graphics, tools and links to help you improve your understanding of environmentally sustainable diets and discuss these with your patients or clients. This is very much a "live" toolkit, and we will be adding more information and tools on a regular basis. Our latest update was made in September 2020, with a significant update to the Reference Guide, with updated statistics and referencing, and a new section on the EAT-Lancet report.	One Blue Dot - the BDA's Environmentally Sustainable Diet Project - British Dietetic Association (BDA)
Sustain, Every mouthful counts: Toolkit:	This toolkit lists key steps local authorities can take to help achieve their net-zero commitments by tackling their food footprint, whilst benefiting health, improving access to nature and creating good jobs locally. Where available, emissions savings data are plotted against actions, to help demonstrate the great potential for taking action on food.	Every mouthful counts: Toolkit | Sustain (sustainweb.org)

[67] http://www.conservation.org/act/live_green/carboncalc/Pages/default.aspx
[68] http://www.nature.org/initiatives/climatechange/calculator/
[69] http://www.stopglobalwarming.org/carboncalculator.asp

Good Food Oxfordshire, Talking About Sustainable Food:	A guide to Talking About Sustainable Eating	Untitled (cloudinary.com)
UN Action Guide on Boosting Nature-Positive Food Production	This series of Action Guides introduces agroecological approaches and regenerative practices that make food production systems more sustainable and resilient. The strategies and actions presented in these Action Guides are evidence-based, proven to be effective, and can be adapted to diverse settings.	419 UNCCD series AG1 Nature-Positve final for web.pdf
UN FAO Tool for Agroecology Performance Evaluation (TAPE)	Based on various existing assessment frameworks, TAPE is a comprehensive tool that aims to measure the multi-dimensional performance of agroecological systems across the different dimensions of sustainability. It applies a stepwise approach at the household/farm level but it also collects information and provides results at a community and territorial scale. The tool was designed to remain simple and to require minimum training and data collection.	Tools | Agroecology Knowledge Hub | Food and Agriculture Organization of the United Nations (fao.org)
UNDP–FAO Climate Action Review (CAR) Tool	The UNDP–FAO Climate Action Review (CAR) Tool aims to support adaptation planners and practitioners' transition from the planning to implementation stages to accelerate transformative climate action in the agriculture and land-use sectors. To do so, the tool presents a practical, step-by-step approach that users can follow to identify actionable entry-points for transformative change in the sector, drawing from adaptation actions included in the nationally determined contributions (NDCs) and National Adaptation Plans (NAPs), among others. The tool is flexible in nature so that it can be easily adapted to country context and the user's strategic priorities.	UNDP–FAO Climate Action Review Tool
UN FAO MRV Platform for Agriculture	The MRV Platform for Agriculture is a comprehensive platform with sample tools, measurement methods, and case studies for monitoring, reporting, and verifying GHG emissions in the agricultural sector	AgMRV - Measurement, Reporting & Verification for Agriculture
US Climate Resilience Toolkit Life Cycle Assessment (LCA) Digital Database:	The LCA Database, part of the LCA Digital Commons Project at the National Agricultural Library, provides open access Life Cycle Assessment datasets and tools. The goal of the LCA Digital Commons Project is to develop a database and tool set intended to provide data for use in LCAs of food, biofuels, and a variety of other bioproducts. It makes North American LCA data more accessible to the community of researchers, policy-makers, industry process engineers, and LCA practitioners.	Life Cycle Assessment (LCA) Digital Commons Database | U.S. Climate Resilience Toolkit
Food and Agriculture Organization of the United Nations, Climate Risk Toolbox Guiding material for climate risk screening :	The Climate Risk Toolbox (CRTB) was developed to support climate-resilient project design. The tool is an open-access resource, hosted on the Hand-in-Hand Geospatial platform, allowing users to obtain a climate risk screening and report containing climate resilient measures, crucial to strengthen project formulation at early stages.	Climate Risk Toolbox (fao.org)
Hoolohan et al., (2020). Design thinking for practice-based intervention: Co-producing the change	This paper develops connections between design thinking and social practice theories, presenting a toolkit intended to support the development of sustainability interventions and policies capable of encouraging sustainable practices. Key developments in design thinking and social practice theories	Design thinking for practice-based intervention: Co-producing the change points toolkit to unlock (un)sustainable practices - ScienceDirect

points toolkit to unlock (un)sustainable practices:	are critically examined, and a toolkit is presented that sensitively combines their conceptual and methodological insights. The toolkit is one of the first resources that enables practitioners to operationalise social practice theories without substantial prior engagement or training. It thereby offers an accessible resource to support the design of initiatives that could disrupt resource intensive practices and support the emergence and normalisation of less resource intensive alternatives. This paper specifically addresses the contribution the toolkit makes to advancing discussions regarding practice-oriented design.	
Consumption-based Emissions Inventory:	A guide for local governments to estimate consumption-based GHG emissions	How to cut your city's consumption-based emissions (c40knowledgehub.org)

6.0 Community engagement/social outcome measures and metrics

6.1. Introduction

Community engagement and social outcomes offer another dimension for understanding the broader impacts of community diet interventions on participants, communities, and societal well-being. Various metrics and methodologies have been used in previous literature, mainly comprising observed *participation rates*, such as measuring the level of community engagement and involvement in intervention activities, programs, or events. Metrics include attendance records, enrolment numbers, and participation surveys to quantify active participation in intervention initiatives, workshops, cooking classes, gardening projects, or other intervention components.

Community surveys and interviews have also been used to assess community perceptions, attitudes, and feedback regarding intervention programs and their impacts on social outcomes (including participants' satisfaction levels, perceived benefits, barriers to participation, and suggestions for program improvement). Qualitative interviews with community members, stakeholders, or intervention facilitators provide deeper insights into participants' experiences, challenges, and successes.

Empowerment and capacity building metrics involve assessing changes in participants' knowledge, skills, self-efficacy, and decision-making autonomy related to dietary behaviours and health promotion. Metrics have included pre- and post-intervention assessments of skills and empowerment. Equity and inclusivity measures have also been utilised to gauge the extent to which intervention programs address disparities, promote social justice, and foster inclusivity among diverse community members, including demographic data, equity assessments, and inclusion indices.

Social Network Analysis (SNA) is a quantitative method used to map and analyse social relationships, interactions, and networks within communities. SNA metrics such as network density, centrality, cohesion, and connectivity have been used to measure the strength and structure of social ties among community members participating in intervention activities.

6.2. Review of the evidence for community engagement/social outcomes measures and metrics

Several studies already summarised in the review have included community engagement/social outcome metrics in their designs. For example, Polley et al., (2021) summarised a range of interventions covering several aspects of health and wellbeing including social outcomes (see Table 27). Farmer et al., (2018) reviewed culinary interventions incorporating a range of health-related quality of life metrics including pre-existing quantitative scales (HRQOL; PNAS; Rosenberg Global Self Esteem Scale; PWB) and qualitative methods (interviews investigating the impact of cooking sessions on participants' lives, participant experience, impact of the programme on income-related food insecurity): see Table 16. Carson et al., (2014) also found wellbeing scales used in their review (QWB-SA, HRQOL): see Table 28, as did Chatterjee et al., (2018) (WEBWMS, HADS, SI): see Table 29.

Milton et al., (2012) reviewed 13 health promotion interventions targeting community engagement as a strategy for promoting health. They found no evidence of positive impacts on population health but did find positive impacts on housing, crime, social capital and community empowerment. Community outcome metrics from the studies are given in Table 37.

Table 37. Evidence on the impacts of community engagement interventions (Milton et al., (2012)

Study	Design	Outcome measures
APCs (Aldbourne Associates and IRIS Consulting, 2003)	large-scale national evaluation using multiple data sources	Community engagement: tenant involvement Community involvement in planning/delivering services: tenant involvement in decision-making Partnership working: extent of partnerships between officers, members and tenants Impact on service provision: improvements in service delivery
Community Champions (Watson et al., 2004)	large-scale national evaluation using multiple data sources	Community engagement: involvement of others as volunteers; number of beneficiaries
Community Champions (Johnstone and Campbell-Jones, 2003)	large-scale national evaluation using multiple data source	Community engagement: community development Community involvement in planning/delivering services: access to local decision-making; influence over Neighbourhood Renewal Fund (NRF) spending Social capital: 'Bonding' social capital Empowerment: skills to engage with funders Partnership working: networking, cohesion and co-ordination

Residents' Consultancy Initiative (ODPM, 2004)	national outcome evaluation using multiple case studies	Empowerment: development of community structures Partnership working: facilitation of partnership development
LSPs (ODPM, 2006)	large-scale national evaluation using multiple data sources	Information flows between community/service providers: effectiveness of influence on council decisions Community involvement in planning/delivering services: range of interests involved in local decision-making; role of marginalized social groups Empowerment: strength of local 'voice'; effectiveness of community influence on regional issues Impact on service provision: appropriateness of services for community needs
SKP (EDuce Ltd, 2005; Johnstone et al., 2005)	large-scale national evaluation using multiple data sources and post-intervention data only	Social capital: 'bonding' and 'bridging' social capital Empowerment: capacity building; increased confidence within the partnership Partnership working: improvements in partnership working Impact on service provision: improvements in service delivery
Drug Misuse Needs Assessment Project (Winters and Patel, 2003)	rapid participatory assessment	Information flows between community/service providers: better community representation in other forums Community engagement: establishment of better links between groups engaged in research and the wider community Community involvement in planning/delivering services: ability to feed into local service planning Social capital: social cohesion Empowerment: community ownership; capacity building. Partnership working: strengthening of partnerships
Community Ownership Housing (Goodlad, Docherty and Paddison, 2003)	outcome evaluation using multiple data sources and comparative data	Social capital: social cohesion. Empowerment: sense of political efficacy
TMOs (Cairncross et al., 2002)	large-scale national outcome evaluation using multiple data sources and comparative data	Housing: repairs; re-let times; rent collection Crime: perceived reduction in crime Community engagement: representation of different social groups on the TMO's board Social capital: 'bonding' social capital; social cohesion
TMOs (Tunstall, 2001)	outcome evaluation using multiple data sources and before-and-after data	Housing: proportion of homes empty; rent arrears; speed and quality of repairs; quality of cleaning and caretaking
ERCF (Pawson et al., 2005)	retrospective assessment using qualitative mixed methods:	Housing: improved response and emergency repair services; catch-up repairs; home improvements; compliance with Decent Homes Standard; limited rent increases Employment: employment and training

	secondary analysis of national statistical sources; documentary analysis	Environment: environmental improvements Crime: crime reduction Community well-being: local regeneration; development of community facilities; community development and capacity building; generating a revival dynamic; reduced estate stigmatization Community needs: youth activities Community involvement: improved tenant participation Impact on service provision: housing management; rent collection; housing management costs
Compacts between local government and voluntary and community organizations (Craig et al., 2002)	qualitative case studies and documentary analysis	Information flows between community/service providers: profile of the VCS; communication levels Empowerment: confidence of VCS Partnership working: levels of informal joint working Impact on service provision: consultation by service providers; policy towards VCS

Meanwhile, O'Mara et al., (2013) reviewed 319 studies involving community engagement interventions to reduce inequalities in health. They found that overall, community engagement interventions were effective in improving health behaviours, health consequences, and social outcomes including participant self-efficacy and perceived social support for disadvantaged groups.

They also found that whilst there is a trend to suggest that there is greater effectiveness of peer-/lay-delivered interventions (as opposed to interventions that take an empowerment approach or those that involve community members in the design of the intervention), this finding was not statistically significant: therefore, no conclusion that one particular model of community engagement or theory of change was clearly more effective than any other could be drawn.

Across the studies, there were improvements in human and social capital, as well as benefits for engagees, including skills acquisition and future employment. Also, there was evidence that interventions improve participants' perceived social support.

The most common participant outcomes measured were *health outcomes* (e.g. behaviours, knowledge, attitudes) (297 studies), followed by *process outcomes* (e.g. acceptability, appropriateness) (103 studies), *personal outcomes* (e.g. empowerment, self-esteem, efficacy, skills) (84 studies), *cost or resource use data or cost-effectiveness*) (70 studies), *community outcomes* (e.g. capacity building, social capital or inclusion) (26

studies), and *other* outcomes (9 studies). However, the actual community metrics were not clearly identified in the main report.

Cornwall Voluntary Sector Forum (VSF) (Cornwall VSF, 2023) produced a Community Hubs Evaluation Report outlining its approach to social outcome evaluation:

The evaluation consisted of four different collection methods:

1. Existing hub member surveys: Individuals who were already receiving support at the time the evaluation commenced were asked to complete a survey, asking questions regarding their hub support experience and outcomes achieved.
2. New hub member surveys: Individuals who sought support from the hubs after the evaluation commenced were asked to complete a survey upon starting their support journey (referred to as the 'pre-survey') and again when their support journey came to an end (referred to as the 'post-survey'). These surveys asked questions regarding their hub support experience, alongside pre and post comparisons of health and wellbeing measures related to the specified outcomes.
3. Hub member interviews: across multiple hubs, hub members were asked for more in-depth information about their support journey and experience.
4. Hub insight logs: Hubs who participated in the evaluation were asked to complete an insight log at multiple stages throughout the evaluation, capturing learning from service delivery, challenges experienced and solutions.

Luger et al., (2020) reviewed 28 community engaged research (CEnR) interventions and identified 43 outcome metrics (covering context, process and outcome evaluation types), as shown in Table 38.

Context measures (n=28) predominantly focus on the conditions under which the research will be conducted and considerations for effective collaborations between researchers and community members.

Process measures (n=43) evaluate the process of engaged research, i.e., aspects of how community engagement occurred.

Outcome measures (n=43) evaluate the outcome or impact of engaged research or the intended effects of community engagement.

Table 38. Community engagement measures by evaluation type (Luger et al., 2020)

Evaluation measure	Measure author	Context	Process	Outcome
ADAPT survey	Rubin et al (2014)	X		
Building Your Capacity Evaluation Survey	Rubin et al (2014)		X	
CBPR [70] Experiences in the Community Academic Partnership Questionnaire	Orellano-Colon et al (2017)		X	
CBPR Model Visioning Guide	Wallerstein (2016)	X	X	X
CBPR Partnership Academy Assessment	Coombe et al (2018)			X
CBPR Partnership Readiness Toolkit	Andrews et al (2011)	X		
CBPR Principles	Braun et al (2012)		X	X
CBPR Rating Scale	Pivik & Goelman (2011)		X	X
CBPR Skills and Training Needs	Digirolamo et al (2012)	X		
CBPR Student Learning Outcomes	Lichtenstein et al (2011)			X
Communities of Practice Evaluation Form	Alcade-Rabanal et al (2018)		X	X
Communities of Practice Performance Criteria	Alcade-Rabanal et al (2018)		X	X
Community Advisory Board Qualitative Evaluation	Cramer et al (2018)			X
Community Engagement in Research Index	Khodyakov et al (2013)		X	
Community Engagement Measure	Goodman et al (2017)			X
Community Grand Rounds Focus Group Protocol	Heaton et al (2014)		X	X
Community Grand Rounds Interview Protocol	Heaton et al (2014)		X	X
Community Health Council Outcomes	Andrews et al (2014)			X
Community Health Initiative Brief Online Survey	Gibbons et al (2016)		X	X
Community Health Initiative Interview Guide	Gibbons et al (2016)	X		
Community Needs Assessment	Goytia et al (2013)	X		
Community Priority Index	Salihu et al (2015)	X		
Critical Outcomes of Research Engagement	Dillon et al (2017)			X
CTSA Engagement Survey	Eder et al (2018)	X	X	X
Cultural Identity Inventory	Hyde (2012)	X		

[70] CBPR = Community-based participatory research

E2 Community Engaged Research Survey	Wallerstein et al (2016)	X	X	X
E2 Key Informant Survey	Wallerstein et al (2016)	X	X	X
Evaluation of Community Capacity-Building Program	Sharpe et al (2015)		X	X
Evaluation of Community Dialogues	Bauermeister et al (2017)		X	
Faith-Based Organisation Capacity Inventory	Tagai et al (2018)	X		
Give-Get Grid	Southerland et al (2013)	X		
Group Level Assessment	Vaughn & Lohmueller (2014)	X		
Guideposts for CBPR Practice	Tremblay et al (2017	X	X	X
Health Equity Indicators Within CBPR	Ward et al (2018)		X	X
I RREACH Community Profile	Maar et al (2015)	X		
Indicators of Community Action for Health	Barbieri et al (2017)	X		
Interorganisational Network Survey	Wendel et al (2010)		X	X
Knowledge Ownership Social Network Analysis	Salsberg et al (2017)			X
Mayo Clinic Garden Cafe Evaluation	Balls-Berry et al (2018)			X
PAIR (Partnership Assessment in CBR)	Arora et al (2015)	X	X	
Participatory Evaluation Measure	Daigneault & Jacob (2009)		X	X
Partnership Indicators	Kothari et al (2011)		X	X
Partnership River of Life	Sanchez Youngman et al	X	X	X
Partnership Trust Tool	CDC (2009)		X	
Partnerships in Social Determinants of Health Interview Guide	Paradiso de Sayu et al	X	X	
Patient Engagement Workbook	Madrid & Wright (2014)	X	X	
PCORI Patient Survey	Forsythe et al (2015)	X		
PECAD Collaboration Survey	Arroyo-Johnson et al (2015)	X	X	X
Peer Research Training Evaluation	Eaton et al (2018)			X
Policy Coalition Evaluation Tool	Hardy et al (2013)		X	X
Potential Partner Interview Guide	Orellano-Colon et al (2017)	X		

PRCHN Network of Community Advisors Survey	Jewett-Tennant et al (2016)		X	X
Prevention Research Center Cost Analysis Instrument	Rabarison et al (2018)		X	X
Progress of Collaborative Action	Collier-Akers et al (2013)			X
Psychological Empowerment Among Youth	Ozer et al (2011)		X	X
Quality Involvement Questionnaire	Morrow et al (2010)	X		
RIH[71] Community Engaged Research Survey	Wallerstein et al (2011)	X	X	X
RIH Focus Group Guide	Wallerstein et al (2011)		X	
RIH Key Informant Survey	Wallerstein et al (2011)	X	X	X
RIH Partnership Interview Guide	Wallerstein et al (2011)	X	X	X
Ripple Effect Tool	Hardy et al (2018)		X	X
Rochester Suicide Prevention Training Institutes Evaluation	White et al (2014)	X	X	X
SC-CTSI Community Mentorship Program Evaluation	Patino et al (2017)		X	X
Social Network Analysis of Partnership Networks	Luque et al (2011)			X
WE-ENACT Inventory	Forsythe et al (2018)		X	
We-VALUE Toolkit and Indicators	Podger et al (2010)		X	X
WINCART Interview Guide	Paige et al (2015)		X	
Youth Community Council Survey	Madrigal et al (2014)			X
YPAR Process Template	Ozer & Douglas (2015)		X	

Gordon et al (2023) reviewed 19 community health interventions and reported that though the interest in CEnR has increased, studies reporting on the findings of fully tested CEnR engagement measurement scales for health studies are sparse. Out of the 53 scales reviewed in this study, only five reported psychometric data. None of those five studies focused specifically on measuring engagement in health research. Details of the community engagement metrics in the reviewed studies are set out in Table 39.

[71] RIH = Research for Improved health

Table 39. Studies investigating the development, testing, and implementation of CEnR engagement measurement scales (2011–2022) (Gordon et al., 2023)

Tool name	Author	Study findings
CERI[72]	Khodyakov et al., 2011	• 12-item CERI Suitable, for large, complex, multi-stage research projects • Strong face and content validity
CERI	Khodyakov et al., 2013	12-item CERI • High degree empirical validity • Community engagement associated with policy-level outcomes
CREAT[73]	Humphries et al., 2014	• 51-item CREAT (per HU2) • Adaptations needed for use as CEnR partner capacity measurement tool
CREAT	Humphries et al., 2019	• 51-item CREAT • Changes made to enhance clarity and applicability
CREAT	Humphries et al., 2021	• 19-item CREAT • Low interitem covariance and scale reliability in two domains
PECaD[74]	Gennarelli & Goodman, 2013	• 50-item PECaD • Low internal consistency (alpha <.70)
PECaD	Goodman et al., 2017	• 96-item PECaD • Strong internal consistency (alpha >.85) • Survey scores not sensitive to missing data
PECaD	Thompson, 2017	• 32-item PECaD • Viable tools must consider literacy levels, and contextual clues • 8 CEnR engagement measurement categories identified
PEIRS[75]	Hamilton et al., 2018–1	• 37-item PEIRS • Good face and content validity • Appropriate for patients with limited literacy
PEIRS	Hamilton et al., 2018–2	• 37-item PEIRS • Good face and content validity • Appropriate for patients with limited literacy
PEIRS	Hamilton et al., 2021	• 22-item PEIRS • Valid and reliable • Enables standard assessment across various contexts
PEIRS	Chung et al., 2021	• 37-item PEIRS • Assessment of stakeholder engagement in research warranted
PPEET[76]	Abelson et al., 2016	• 30-item PPEET • One tool with subscales for three distinct audiences • Applicable in a wide range of health settings
PPEET	Garratt et al., 2022	• 30-item EBNOR • Adequate comprehensibility and content validity
PPIAS[77]	Maccarthy et al., 2019	• 9-item PPIAS • Validated tool for evaluating patient engagement in basic science and preclinical research
REST[78]	Goodman, 2019	• 32-item REST • Aligns with eight engagement principles
REST	Goodman et al., 2021	• 9-item REST • High correlation with 32-item REST • High internal consistency

[72] CERI = Community Engagement in Research Index
[73] CREAT = Community Research Engagement Assessment Tool
[74] PECaD = Program for the Elimination of Cancer Disparities
[75] PEIRS = Patient Engagement In Research Scale
[76] PPEET = The Public and Patient Engagement Evaluation Tool
[77] PPIAS = Patient and Public Involvement Assessment
[78] REST = Research Engagement Survey Tool

REST	Goodman et al., 2022	• 32-item REST • Valid and reliable tool to assess community engagement in health research
REST	Bowen, 2022	• 32-item REST • REST implementation feasible • Small percent noted time as barrier

In summary, community diet interventions employ a range of metrics, encompassing participation rates, community surveys and interviews, empowerment and capacity building measures, and social network analysis. These metrics enable comprehensive evaluations of intervention effectiveness and contribute to the development of community-driven, culturally tailored strategies for promoting health and well-being within diverse communities. Before moving on to the next section, Table 40 presents a range of resources and toolkits linked to community engagement and social outcome measures and metrics.

Table 40. Resources for diet and food-related community engagement/social outcome methods and metrics

Source	**Description**	**Link**
Healthy Cities Toolkit:	The Healthy Cities Toolkit aims to understand what factors impact the health and wellbeing of those living and working in cities. The Toolkit is based on the findings of over 250 systematic reviews. It is designed to support practitioners, policymakers, and the public in improving the health of the population in their cities. The Toolkit provides evidence-based summaries of what is likely to benefit or negatively impact health. The Toolkit pages should be used alongside professional expertise and local knowledge to move from the summarised information to evidence-informed decisions about what might work best in your city context. The Healthy Cities Toolkit is an accessible summary of urban health research and provides a rigorous assessment of over 50 approaches to improving urban health, each summarised in terms of: impact, resource implications, and the quality of the evidence supporting the approach.	Healthy Cities Toolkit – Healthy Cities Toolkit (healthycitiescommission.org)
Sustain Telling stories and shaping solutions: A toolkit for empowering people who have lived experience of food poverty	There is currently a lack of voice for grassroots people, those who are experiencing food poverty and hunger, their peers and allies within their community, both within the sector and more widely within society. This toolkit covers: Why involve people with lived experience? Why do people want to get involved? Who are the people we want to empower? What are the challenges? What do we mean by empowerment? Recruiting people to become involved: Minding our language: Four core principles and case studies: Co-production: Building relationships: Influencing and impact: Building a social movement: Advice for people with lived experience who get involved: Practical consideration	Telling stories and shaping solutions: A toolkit for empowering people who have lived experience of food poverty | Sustain (sustainweb.org)
Age UK A local approach to promoting good nutrition and hydration in later life toolkit:	The toolkit summarises the learning from the Greater Manchester Nutrition and Hydration (GMNH) pilot programme, which operated in 6 localities between 2018 and 2021. It provides a step-by-step methodology, with ideas and resources to support implementation.	final-nutrition-and-hydration-toolkit---a-local-approach.pdf (ageuk.org.uk)

UK Data Service Social Network Analysis: Getting and Marshalling Data:	Introduction to SNA and resources for data management	Social Network Analysis: Getting and Marshalling Data (ukdataservice.ac.uk)
Oxfam Handy NGO Guide to Social Network Analysis	In 9 pages, the guide sets out how to run a relationship mapping exercise, how to examine the influence of the different network members over the issue that is being addressed (pretty much the same as Oxfam's Power Analysis approach). It then gets on to how to analyse the network, with some examples from an SNA by IRC's team in Sierra Leone.	Handy NGO Guide to Social Network Analysis | From Poverty to Power (oxfam.org.uk)
Home Office Social Network Analysis How to Guide:	This guide is intended to help local areas and police forces use intelligence data to undertake social network analysis of their local gang issues.	Social network analysis: How to guide (publishing.service.gov.uk)
Camacho et al., (2020). The Four Dimensions of Social Network Analysis: An Overview of Research Methods, Applications, and Software Tools	Social network-based applications have experienced exponential growth in recent years. One of the reasons for this rise is that this application domain offers a particularly fertile place to test and develop the most advanced computational techniques to extract valuable information from the Web. The main contribution of this work is three-fold: (1) we provide an up-to-date literature review of the state of the art on social network analysis (SNA);(2) we propose a set of new metrics based on four essential features (or dimensions) in SNA; (3) finally, we provide a quantitative analysis of a set of popular SNA tools and frameworks.	(PDF) The Four Dimensions of Social Network Analysis: An Overview of Research Methods, Applications, and Software Tools (researchgate.net)

7.0. Diet interventions and support for growers/businesses measures and metrics

7.1. Introduction

Evaluating the impact of community diet interventions on food producers and businesses is the final relevant dimension to understanding the broader economic and socio-economic implications of intervention programs on local food systems, agricultural practices, and food-related enterprises. Various metrics and methodologies are employed to assess changes in producer behaviour, market dynamics, economic viability, and social equity within food supply chains.

These comprise *producer surveys and interviews*, used to assess the perceptions, experiences, and outcomes of food producers participating in intervention programs. Surveys may inquire about changes in production practices, yields, income levels, market access, and business sustainability following intervention implementation. Qualitative interviews with producers, farmers, or food entrepreneurs provide deeper insights into their motivations, challenges, and aspirations.

The following methods can also be used but are not covered in the review.

Market assessments and economic analyses can be used to evaluate changes in market dynamics, consumer demand, and economic performance within local food systems affected by intervention initiatives. Metrics such as sales data, market surveys, price trends, and economic indicators quantify the impacts of intervention programs on food sales, revenue generation, job creation, and value chain development. Economic analyses may employ cost-benefit analysis, input-output modelling, or value chain analysis to assess the net benefits and economic sustainability of interventions for food producers and businesses.

Value chain mapping and analysis identifies key actors, processes, and relationships within food supply chains influenced by intervention programs. By tracing the flow of products, services, and value-added activities from producers to consumers, value chain analysis elucidates the distribution of costs, benefits, and power dynamics along the supply chain.

Business development and capacity building assesses changes in producers' entrepreneurial skills, organisational capacity, and access to resources and support services. Metrics include training participation rates, business plans, market linkages,

and access to credit measure the effectiveness of intervention programs in fostering entrepreneurship, innovation, and resilience among food producers and businesses.

7.2. Review of the evidence for food-related growers/businesses measures and metrics

In the above review, examples of food business metrics have been summarised, including food purchase and supply change (Guo et al., 2022; see Table 13; Gittlelsohn et al., 2012; see Table 18) and food waste in educational and retail settings (Reynolds et al., 2017; see Table 19).

Vasquez et al (2017) reviewed CSA interventions for diet and health improvement. They found a lack of experimental research in this area, and results of studies were mixed. Intervention/Outcome methods and measures combined CSA members and producers, and are summarised in Table 41.

Table 41. Summary of community-supported agriculture (CSA) studies that investigate dietary and health-related changes (Vasquez et al., 2017)

Author	Sample	Design	Methods
Andreatta and colleagues, 2008	N=10 (NC farmers) N=22 (NC low-income households)	Mixed methods	Free CSA shares were given to low-income families • Pre- and postharvest semi-structured interviews and surveys of farmers and CSA members • CSA member food journals
Berning, 2012	County-stratified, state-level data: N=17,140 n=2,379 (CT) n=1,753 (ME) n=6,653 (MA) n=1,870 (NH) n=2,574 (RI) n=1,911 (VT)	Correlational	Secondary data analysis of Centers for Disease Control and Prevention Behavioural Risk Factor Surveillance System data • Access to local food calculated by counting CSA farms and farmer's markets per person per square mile
Cohen, 2012	N=583 n=402 CSA n=181 non-CSA New York City, NY	Prospective cohort study	Convenience sample • "What do you eat" online survey at start of season and 6-wk later collected frequency and quantity of 9 fruit and vegetable categories, home meals, and demographic data

Curtis and colleagues, 2013	N=15 (4 CSA farms) Logan, UT	Repeated measures	Series of preseason, monthly, and postseason surveys measuring CSA use, preparation, and storage, home meals • CSA share items and grocery store receipts tracked for nutrition/dietary intake information
Goland, 2002	n=22 (spring) n=24 (fall) Central Ohio	Descriptive	Spring survey collected CSA demographics, expectations, motivations for joining, number of days they ate at home, and recall of dinners for previous week • Fall survey collected much of same information on spring survey as well as questions regarding food-related behaviours and satisfaction
Landis and colleagues, 2010	N=280 (5 CSA farms) n=210 CSA n=97 Non-CSA Central North Carolina	Quasi-experimental	Convenience sample of CSA members and demographically similar controls • Survey administered at end of CSA season collected demographics, motivations, use, satisfaction, and consumption of fruits and vegetables
Oberholtzer, 2004	N=13 farmers N=276 members (4 farms) Southeastern Pennsylvania	Mixed methods	Interviews with farmers • Survey mailed (January 2002) to CSA members on farm contact lists that explored member experience, satisfaction, and retention
Perez and colleagues, 2003	N=274 (quantitative) N=17 (qualitative) Central coast of California	Mixed methods	Survey collection with follow-up interviews and focus groups exploring CSA member attitudes and experiences
Quandt and colleagues, 2013	N=50 n=25 (CSA) n=25 (control) Forsyth County, North Carolina	Randomized, controlled feasibility study	Low-income participants in the intervention group were provided 5 education classes and a box of fresh produce for a period of 16 wk • Telephone interviews were conducted at baseline and follow-up to measure home

			availability and intake of fruits and vegetables
Russell and Zepada, 2007	N=23 Madison, WI	Qualitative	Focus groups explored attitudes and behavioural change related to CSA participation
Uribe and colleagues, 2012	N=115 Arizona	Correlational	Convenience sample of current CSA members • Online survey collected data on attitudes and behaviours related to food and sustainability as measured by the New Ecological Paradigm scale

Gittelsohn et al., (2013) reviewed 13 community food interventions. Interventions made use of signage and menu labelling to promote healthy food options. Several studies promoted healthier cooking methods; however, just introduced new healthy menu options. Outcome measures for consumers were limited but, in many cases, showed improved awareness and frequency of purchase of promoted foods.

The authors concluded that community interventions in prepared-food sources showed encouraging results at the store level. The range of assessment outcomes are summarised in Table 42.

Table 42., by type of intervention: Interventions conducted in speciality restaurants (Gittelsohn et al., 2013)

Study	**Design**	**Feasibility assessment measures**	**Process evaluation measures**	**Prepared-food source impact measures**	**Consumer impact measures**
Baltimore Healthy Carryouts	Experimental design; pre–post assessment (n = 8)	Informal observation; staff reports; interviews with carryout owners or staff	Direct observation	Sales	Purchasing; awareness; self-reported body mass index
Good for You	Nonexperimental; pre–post sales analysis, broken down by quarter (n = 7)	Launched simultaneously in all Target Food Avenue restaurants; not assessed at individual store level	None	Sales	None
Steps to a Healthier Salinas	Nonexperimental; no pre–post assessment; intervention trial, voluntary	Assessments, discussion with health educators	Surveys with store owners; informal observation	None	Modified Behavioural Risk Factor Surveillance System

	participation; no comparison group (n = 16)				
Horgen and Brownell 2002	Nonexperimental; pre–post assessment (n = 1)	Informal visits, daily check-in	Informal visits, daily check-in	Sales	Behavior
Coeur en Santé St-Henri	Nonexperimental; no pre–post assessment (n = 2)	None	None	None	Purchasing; attitudes
TrEAT Yourself Well	Quasi-experimental; no pre–post assessment; comparison regions (n = 4)	None	None	None	Awareness; attitudes
Tandon et al 2011	Pre–post assessment; comparison counties	None specified	None specified	None	Awareness; behavior (calories consumed)
Shape Up Somerville	Quasi-experimental; nonexperimental for restaurant portion of intervention; intervention trial, voluntary participation (n = 21)	Environmental change assessment; owners' compliance and perceived impact	Extensive process evaluation; participation and adherence to intervention elements	Owner survey (menu changes, sales, nutrition awareness)	None for restaurant intervention; assessment at child and household level (change in body mass index)
Smart Menu Program	Nonexperimental; pre–post assessment; intervention trial, voluntary participation; no comparison group (n = 6)	Interviews with restaurant owners or managers	Observation of nutrition information being posted	Sales	Awareness; behavior
The Healthy Options Program	Nonexperimental; pre–post assessment (n = 4)	Interviews with owner and staff	None	Sales	Awareness; behavior
Healthy Howard Initiative	Nonexperimental design; intervention trial, voluntary participation; no comparison group	Restaurant owner or manager survey; focus group; recipe analysis	Informal observation, telephone communication; annual health inspection; recertification every 2 years	Restaurant owner or manager survey (recall of sales)	Psychosocial, behavioural survey
Healthy Restaurant Program	Nonexperimental design; pre–post assessment; intervention trial, voluntary participation; no comparison group	Interviews with chefs; survey of restaurant managers or staff	Annual menu analysis; annual observation	Restaurant owner survey	Awareness; attitudes

Winners Circle Healthy Dining Program	Nonexperimental; intervention trial, voluntary participation; cross-sectional survey of community awareness of program; no comparison group	Survey of managers	Tracked reach and dose using Winner's Circle team reporting forms; menu review	None	Awareness

Looking more widely, Hecht & Neff (2019) reviewed 19 interventions aimed to redirect surplus food for human consumption to improve food security and reduce waste. The most reported metric was the *weight of food recovered*. *Few studies reported client outcome measures*. Comparison across studies was challenging due to inconsistent metrics and insufficiently detailed methodology. The authors concluded a need for additional evaluation of food rescue interventions and a standardised methodology. A summary of key metrics is displayed in Table 43.

Table 43. Study design, food rescue metrics, impact measures for included studies (n = 19) (Hecht & Neff, 2019)

Reference	**Sample**	**Key metrics**
Alexander et al., 2008	Two retailers; unreported number of interviews	Across 2 days: • Weight of food donated • Weight of food accepted • Weight of food delivered • Weight of food served • Weight of food consumed
Bonaccorsi et al., 2016	90 food samples	Across 90 food samples: • Total aerobic microbial count • Presence of Escherichia coli, Salmonella spp, Staphylococcus aureus, Campylobacter spp, Sulphite reducing clostridia
Cicatiello et al., 2016	One supermarket	Over one year: • Number of deliveries (total and avg./month) • Weight of food rescued (total and avg./delivery) • Categories of food rescued (e.g., bread) • Economic value of rescued food (based on retail price) • Environmental value of rescued food (water and ecological footprint of rescued food) • Possible number of servings prepared with rescued food • Cost-revenue estimate
Cicatiello et al., 2017	One supermarket	Over one year:

		• Weight of food rescued (overall and percent by food category) • Economic value of rescued food (based on retail price)
De Boeck et al., 2017	21 students, six teachers, two parents	Over two school terms: • Weight of food rescued • Direct cost of the program • Volunteer hours • Perceptions of teachers, students and parents of intervention acceptability and impact • Equivalent meals rescued
Facchini et al., 2018	Unreported number of interviews; 12 example food redistribution sites	Weight of food rescued (using various denominators, e.g., annually, per event) • Sources of rescued food • Org. activities (e.g., gleaning, serving dinner)
Garcia-Silva et al., 2017	One county coalition	Over 22 months: • Weight of food rescued • Meals rescued • Donor agencies recruited • Recipient agencies (pantries) recruited
Hoisington et al., 2001	50 gleaners observed; subsample of 29 surveyed	Weight of food gleaned • Proportion of food gleaned donated vs. taken home by gleaners • Use of produce taken home by gleaners • Perceived benefits of gleaning among participants
Laakso, 2017	3 schools; 24 diners	Diner perspectives on how the leftover lunch has impacted their daily routine, and how important the meal is to them
Milicevic et al., 2016	44 total samples (11 food items each sampled daily)	Hygienic status of food rescued at four time points and under several different preservations terms
Mirosa et al., 2016	Interviews: 13 (two FoodShare staff and 11 stakeholder organizations); survey: 40 volunteers	Impact of participation in FoodShare on: • Food donors • Financial donors • Recipient agencies • Volunteers

Martínez-Donate et al., (2015) conducted a healthy eating intervention targeted to shops and restaurants in a rural community setting, using the following metrics: pre-post- test intercept surveys (evaluation of customer-level reach and effectiveness Surveys included questions on satisfaction with healthy options available, perceived healthiness of the foods purchased, and whether participants purchased any foods promoted as healthy in the outlet). At post-test in the intervention community only, questions also asked about the intervention 'branding' name and logo recognition, exposure to intervention activities/materials/messages, and, among those exposed, degree of appeal, ease of interpretation, helpfulness to decide purchase, and whether the respondent ordered/purchased any intervention-branded foods.

To evaluate the impact of the intervention on the food environment researchers used the Nutritional Environment Measures Surveys (NEMS). NEMS is an observational audit tool of nutrition environments. Restaurants received points for a variety of measures related to availability of healthier foods, pricing, nutrition information or healthy symbols, and signage facilitating healthy eating. Stores received points for availability, pricing, and quality of healthier foods. For both, restaurant and stores, higher overall scores represent conditions more conducive to healthy eating.

In summary, community diet interventions employ a range of metrics and methodologies to evaluate food producers and business outcomes, encompassing producer surveys and interviews, market assessments and economic analyses, value chain mapping and analysis, social and environmental certification, and business development and capacity building measures. By assessing changes in producer behaviour, market dynamics, economic viability, and social equity within food supply chains, these metrics enable comprehensive evaluations of intervention effects and inform strategies for promoting sustainable food production, economic development, and community resilience within local food systems. Table 44 displays resources and toolkits relating broadly to food producers and businesses.

Table 44. Resources and toolkits for food growers/ businesses measures and metrics

Source	Description	Link
FareShare Food Efficiency Framework:	Using this framework will enable you to prepare and plan in advance for any potential food surplus within your operation. Food businesses are fast moving operations; our approach is to ensure this framework can be implemented seamlessly into your business and become part of your standard operational procedure. A small amount of time upfront will ensure you have the systems in place to maximise the social value of keeping food in the human food chain that may otherwise be thrown away.	Fareshare toolkit v5.indd
Sustain Food Co-ops Toolkit - a simple and comprehensive guide to setting up food co-ops:	This 81-page, comprehensive toolkit has been produced as part of the Big Lottery funded Making Local Food Work programme to help more communities set up their own food co-ops and buying groups. Packed with easy-to-follow tips and advice, the toolkit covers issues such as how to buy fresh produce, food hygiene, pricing, planning, promotion and marketing.	Food Co-ops Toolkit - a simple and comprehensive guide to setting up food co-ops | Sustain (sustainweb.org)
Social Farms and Gardens, Business & Corporate Partnerships Toolkit:	The Business Partnerships Toolkit is an extremely useful resource intended as a primer for community growing groups to share with local businesses and potential corporate partners, which explains why and how businesses can get involved with local groups of whatever size and scale. Expertly researched and written, the Business Toolkit is useful for any groups	Business & Corporate Partnerships Toolkit | Social Farms & Gardens (farmgarden.org.uk)

	thinking about working with the business sector to increase their income.	
Locality, Pathways to Good Work: Toolkit for community organisations:	This toolkit is designed to help organisations understand what good work is and improve existing practices by focusing on seven key dimensions.	Pathways to Good Work: Toolkit for Community Organisations - Locality
Fife Council Community Engagement Toolkit:	This toolkit gives you the tools and information you need to run good community engagement. It will help you embed this way of working into your work going forward. What people can use it for: This toolkit can be used in the planning, delivery and evaluation of your work. We recommend checking the steps outlined below, anytime your service or organisation is undertaking decisions that affect the community you serve.	Community Engagement Toolkit | Fife Council
What Works Wellbeing, Places and community:	Our evidence, analysis and guidance looks at how community wellbeing can be understood and improved. Our research looks at: community wellbeing and how it is linked to individual wellbeing: community spaces and infrastructure: social relations: loneliness and social isolation: heritage: housing: culture, arts, and sport: inequalities in wellbeing, and the drivers of wellbeing inequalities: using locally available data to improve wellbeing	» Places and community (whatworkswellbeing.org)
WRAP's Data Capture Sheet:	Provides sector-specific guidance on food loss quantification methods. It is intended for common use by food businesses in the UK but can be applied worldwide	Food loss and waste data capture sheet | WRAP
International Food Policy Research Institute (IFPRI):	Food loss methodology for measuring quantities of food lost along the value chain as well as reductions in food quality	Reality of Food Lses: A New Measurement Methodology Munich Personal RePEc Archive (uni-muenchen.de)
UN FAO Technical Platform:	Measurement and reduction of food loss and waste, includes a variety of publications addressing food loss	Publications | Technical Platform on the Measurement and Reduction of Food Loss and Waste | Food and Agriculture Organization of the United Nations (fao.org)
UN FAO Methodology:	For conducting food loss analysis case studies. The methodology focuses on revealing and analysing the multidimensional causes of losses in selected food supply chains, identification of critical loss points, and recommendation of critical loss points and recommendations of feasible food loss reduction solutions and strategies	content (fao.org)
UN FAO Food Loss and Waste Protocol:	Provides tools for measuring food loss/waste including the FLW Value Calculator and the FLW Standard. The FLW Standard enables a range of actors (countries, companies, other organisations) to measure how much food loss/waste is created and identify where it is	Food Loss & Waste Protocol | World Resources Institute (wri.org)

	occurring, thus enabling targeted food loss/waste reduction efforts	
FLW Value Calculator:	Provides tools for measuring food loss/waste including the FLW Value Calculator	FLW Value Calculator - Food Loss and Waste Protocol (flwprotocol.org)
FLW Standard:	The Food Loss and Waste Protocol (FLW Protocol) provides tools for measuring food loss/waste including the FLW Standard	FLW Standard - Food Loss and Waste Protocol (flwprotocol.org)
ReFED Insights Engine:	Provides a number of tools including the Impact Calculator, which helps to quantify the climate, natural resource and food security impacts of wasted food at various levels (farms, retail, residential, etc.)	ReFED Insights Engine
Food Waste Atlas:	Information for companies and governments to understand how food loss/waste is occurring	The Food Waste Atlas
Smart Scales:	Smart scales to weigh/categorise food waste, identify contributing factors, and calculate costs of the waste	IKEA Food: "Food Is Precious" Food Waste Initiative - Food Loss and Waste Protocol (flwprotocol.org)
FAO Technical Platform on the Measurement and Reduction of Food Loss and Waste:	Includes a variety of publications (case studies, reports, discussion papers, etc.) addressing food waste	
Community Food Growers Network, Working With Your Council Toolkit:	The Working with Your Council toolkit outlines how to build better relationships with councils and just how much this can benefit the security and sustainability of a project.	Working-with-council-toolkit.pdf (cfgn.org.uk)
Sustain Council toolkit: Councils and food growing:	Useful information, links and signposting to help councils support food growing initiatives. Where to start: 3 quick actions: Choosing your next steps: Approaches to consider: Seeking good practice: What other Councils are doing: Do your homework: useful strategy documents: Outside of London/National: Useful resources and websites: Free advice and support: join our food growing networks!: Schools: Social Prescribing: Practical Support & Signposting	Council toolkit: Councils and food growing | Sustain (sustainweb.org)
Sustain, The Fringe Farming Toolkit:	The Fringe Farming toolkit lays out practical steps and advice to help growers, aspiring growers, campaigners, food partnerships and local community groups wanting to progress either their own agroecological peri-urban market garden or the broader fringe farming movement. It should also be a handy resource for local and national authorities to boost the delivery of their economic, environmental, health, and food procurement strategies and objectives. Each guide (or tool) of the toolkit addresses three key barriers: Accessing land for agroecological food production: Understanding how the planning system works for fringe farms: Gaining local authority support for fringe farming	The fringe farming toolkit | Sustain (sustainweb.org)
Sustain, Urban Farming Toolkit: A guide to	The Urban Farming Toolkit is a practical guide to help prospective growers establish and run a successful growing site that generates an income. Contents: 1. Find	Urban Farming Toolkit: A guide to growing to sell in the city | Sustain (sustainweb.org)

growing to sell in the city:	and secure a suitable growing site: What is a viable site? Find a potential site: 2. Creating the garden: Planning the layout: Buying tools: Chapter 2: Action summary: 3. Establish growing methods: Plan your rotation: Plan your growing year: Sowing seeds: Planting out: Harvesting: Dealing with pests and diseases: Chapter 3: Action Summary: 4. Find your market: Secure your market: Create a label: Packing your produce: Chapter 4: Action Summary: 5. Creating the business: Making the numbers work: Choosing a business model: Creating policies: Good record keeping: Chapter 5: Action Summary: 6. Engaging the community: Trainees: Running volunteer days: Teaching and outreach: Chapter 6: Action Summary: Case studies: Springfield Park: Hackney Tree Nursery: Clissold Park	
CSA, Resource A-Z:	A wide range of information and guidance on setting up a CSA project	Resource A-Z (communitysupportedagriculture.org.uk)
Food and Agriculture Organization of the United Nations, Developing Sustainable Food Value Chains - Practical guidance for systems-based analysis and design:	This brief outlines a rigorous and standardized approach for value chain analysis and design, taking a systems perspective to analyse and influence the behaviour and performance of value chain actors influenced by a complex environment. The brief also covers the design of upgrading strategies and associated development plans, based on the identification of root causes of value chain bottlenecks and using a participatory and multistakeholder approach. The brief is primarily based on FAO's Sustainable Food Value Chain (SFVC) framework which promotes a systems-based development of agrifood value chains that are economically, socially and environmentally sustainable, as well as resilient to shocks and stressors. The end-product of the application of the methodology is a VC report with four components. The first two components, a functional analysis and a sustainability assessment, make up the VC analysis. The last two components, an upgrading strategy and a development plan, represent the VC design	
Food Ethics Council, Ethics: A Toolkit for Food Businesses:	Food businesses throughout the supply chain face daily dilemmas about where their products come from, and who or what is affected by them. This toolkit, generously funded by the Naturesave Trust, helps businesses get to grips with these issues, introduces key ideas in ethics, and provides a framework for decision-making. 'Ethics: a toolkit for food businesses' contains: A crash course in ethics and how it relates to business; An ethical decision-making tool; Business ethics myth busters; and: A transparency test.	Ethics: a toolkit for food businesses – Food Ethics Council

8.0. Client experience of diet and food-related interventions measures and metrics

8.1. Introduction

Assessing participant experience is the final dimension covered in this report for understanding the effectiveness, acceptability, and perceived benefits of community diet interventions from the perspective of programme participants. Various metrics and methodologies are employed to evaluate participant engagement, satisfaction, knowledge gain, behaviour change, and overall perceptions of intervention programs.

Participant surveys are commonly used to assess satisfaction levels, perceived benefits, and overall experience. Surveys may include Likert-scale questions, open-ended prompts, and validated scales to measure participant satisfaction, programme relevance, perceived effectiveness, and intentions to sustain behaviour change. Surveys may be administered at multiple time points during and after the intervention to capture changes in participant experiences over time.

Focus groups and interviews to generate qualitative methods and gather in-depth insights into participants' experiences, attitudes, and perceptions of intervention programs. Focus groups provide a forum for participants to discuss their experiences, share opinions, and provide feedback on program content, delivery, and impact. Interviews allow for individual exploration of participant perspectives, enabling researchers to uncover nuanced experiences, barriers, and facilitators to behaviour change.

Participant observations involve researchers observing participants' behaviours, interactions, and experiences during intervention activities, workshops, or group sessions. Observational data provide insights into participants' engagement levels, interactions with facilitators and peers, and reactions to program content and materials. Participant observations complement self-reported data by capturing real-time behaviours and dynamics within intervention settings:

Process evaluation metrics are used to assess intervention experience, fidelity, and reach, in relation to the implementation and delivery of programmes. Metrics such as attendance records, session completion rates, and programme adherence measures quantify the extent to which participants engage with intervention activities and receive the intended dose of intervention components.

8.2. Review of the evidence for diet and food-related client experience measures and metrics

Pescheny et al., (2020), Luger et al., (2020) and Farmer et al., (2018) above reviewed community diet and social prescribing interventions and documented outcome measures, including a range of quantitative and qualitative process metrics (see Tables 30, 38 and 16).

The Bromley-by-Bow Centre (2021) have developed an outcomes framework with a set of 'stretch outcomes' relevant to assessment of participant experience. These outcomes are listed in Table 45.

Table 45. Client experience stretch outcomes (Bromley-by-Bow Centre, 2021)

Category	**Outcomes**
Basic needs met:	From being supported with practical tasks to: Securing tangible resources to: Concrete needs being met and potentially further opportunities sought
Connection to others:	From a simple feeling of connection Stability of a relationship over time to: A 'family' network and diversity of connections that help a person grow
Confidence:	From sense of self to: Freedom, self-belief, assertiveness and broad horizons (growth) to: Capacity to act and resourcefulness
Connection to support and resources:	From connection to support and resources to: Know how to: Teaching others
Feeling known:	From recognition to: Belonging
Contribution:	From contribution to: Reciprocity

Tay et al., (2021) reviewed 22 co-designed nutrition interventions in which a variety of participant experience measures were included. No study implemented a complete co-design process, most just reported positive health outcomes or health behaviour outcomes attributed to the intervention; hence, associations between co-design techniques and effectiveness could not be determined. Outcome measures including those of relevance to client experience are displayed in Table 46.

A total of 11 techniques were used to consult stakeholders' perspectives in the included studies. Three collegiate studies (which represent the highest level of stakeholder engagement), utilised various methods including the photo-voice method, workshops, interviews, stakeholder meetings and dietary assessment.

Across the other studies, focus groups were most common used (n=9), followed by tailoring of intervention content to individual's preferences, characteristics, or needs (n=5), and surveys (n=5).

Table 46. Study characteristics, co-design methods used (Tay et al., 2021)

Study Reference and Aim	Study Design, Participants and Other Stakeholders, Setting, and Time of Study	Participation Method, Data Collection Techniques, Data Analysis Techniques	Research Stage at Participation Occurred
Adams et al. (2012): To gain an understanding of Aboriginal people's perspectives on food and food insecurity as an action research method to strengthen food programmes.	Study design: Qualitative (Participatory Action Research). Participants: Men and women (n = 10) in their twenties and thirties. Other stakeholders: N/A. Setting: Aboriginal community organisations located in regional Victoria, Australia. Time of study: 2009–2010	Participation method: Photo-voice method. Data collection techniques: Participants took photographs relating to food; focus group discussions; individual interviews for participants storytelling about most significant photographs. Data analysis techniques: Thematic analysis	Assess background knowledge and evidence, assess user needs to inform intervention focus.
Burford et al. (2015): Utilise participatory design techniques to inform the design of a study that introduces mobile tablet devices in the self-management of type 2 diabetes in a primary healthcare setting.	Study design: Qualitative (Participatory Action Research). Participants: Research team members (n = 4); health professionals: general practitioners, specialist, nurses, practice manager (n = 11); patients (n = 30). Age of participants was not reported. Other stakeholders: N/A. Setting: A general practice super-clinic in Australia. Time of study: Not reported.	Participation method: Facilitated design workshops. Co-design techniques: Examination of available m-health apps and websites, use of iPads to view m-health. Data analysis techniques: Thematic analysis	Assess user needs to inform intervention focus, assess user needs to inform technology.
Sharma et al. (2010): Describe Health Foods North Programme intervention development and outcomes.	Study design: Qualitative Participants: Inuit and Inuvialuit people (n unspecified). Age of participants was not reported. Other stakeholders: Staff from food retailers and local organisations (n unspecified). Setting: Community-based; Arctic regions of Nunavut and the NWT, Canada. Time of study: 2008–2009.	Participation method: Interviews and workshops. Data collection techniques: In-depth interviews with community stakeholders, dietary assessment using 24-h recall to target foods for intervention programme, community workshops. Data analysis techniques: Thematic analysis	Assess user needs to inform intervention focus.
Chojenta et al. (2018): Describe the process of the redevelopment and expansion of Cooking for One or Two, a community-based nutrition education program for older adults.	Study design: Qualitative (focus groups). Participants: Community-dwelling older adults (n = 111). Age of participants was not reported. Other stakeholders: Health	Participation method: Three-stage iterative intervention development. Data collection techniques: Focus groups and expert consultation, iterative drafting and road-testing of	Develop intervention content, prototype testing, assess user needs to inform intervention focus.

	promotion experts (e.g., a Fellow of the Dietetic Association of Australia); media communication students. Setting: Community-based, large regional city in New South Wales, Australia. Time of study: 2011–2013	recipe book, telephone interviews, focus group. Data analysis techniques: Not reported.	
Kitzman-Ulrich et al. (2016): To gather opinions of parent and caregiver dyads on barriers and facilitators, motivators and preferences for a health and weight loss program from a social-ecological perspective.	Study design: Qualitative (Participatory Action Research). Participants: African American parents or caregivers (n = 30) with a mean age of 46.1 (SD = 9.8) years, young people (n = 25) with a mean age of 12.4 (SD = 1.1) years. Other stakeholders: Graduate students in psychology and public health. Setting: Family-based, South Carolina, USA. Time of study: Not reported.	Participation method: Focus groups. Data collection techniques: Focus groups exploring Social Cognitive Theory predictors of weight loss. Data analysis techniques: Content analysis.	Assess user needs to inform intervention focus
van Dongen et al. (2017): To adapt an existing experimental nutrition and exercise intervention for frail elderly people to a real-life setting; To test the feasibility and potential impact of this prototype intervention in the new setting.	Study design: Qualitative (Participatory Action Research). Participants: Dietitians and physiotherapists (n = 8); Interview participants from the original intervention (n = 13) and possible future participants (n = 9); Community-dwelling (n = 25) elderly ≥65 years (74.1 ± 6.8 years); healthcare professionals including dietitians, physiotherapists, coordinator (n = 7); focus group participants (n = 14). Other stakeholders: N/A. Setting: Community-based, Harderwijk, The Netherlands. Time of study: Not reported.	Participation method: 6-stage intervention mapping process followed by pre–post pilot testing of intervention. Data collection techniques: Literature review, semi-structured interviews, focus groups, iterative discussion of findings, pre–post pilot study with interviews and focus groups. Data analysis techniques: Thematic analysis.	Assess user needs to inform intervention focus, prototype testing, pilot/real-world testing.
Velema et al. (2018): To examine effects of a healthy worksite cafeteria ("worksite cafeteria 2.0"] intervention on food purchases. Related works: Velema et al. (2017), Velema et al. (2019)	Study design: Randomised Controlled Trial. Participants: Primary outcome was sales data (unspecified n) from 30 cafeterias; 1651 employees. Age of participants was not reported. Other stakeholders: Expert interviews (n = 14) and seven focus groups (n = 45). Setting: Worksite cafeterias in The Netherlands. Time of study: 2016.	Participation method: Focus groups to inform intervention design. Data collection techniques: Focus groups. Data analysis techniques: Thematic analysis	Assess background knowledge and evidence, assess user needs to inform intervention focus.
Staffileno et al. (2015): Describe process of	Study design: Mixed methods. Participants:	Participation method: Iterative intervention	Assess user needs to inform intervention focus,

adapting a face-to-To adapt a lifestyle change intervention from face-to-face to web-based.	African American adults (18–45 years old) with pre-hypertension. Focus group and survey (n = 11); prototype testing (n = 8); beta testing (n = 8). Other stakeholders: None reported. Setting: Rush University. Medical Center (hospital): USA. Time of study: Not reported.	development and pilot testing. Data collection techniques: Focus groups, intervention, development/conversion from face-to-face to eHealth modules, prototype testing in interactive workshop session, pilot testing. Data analysis techniques: Thematic analysis	prototype testing, pilot/real-world testing.
Ard et al. (2010): Evaluate the effectiveness of a culturally enhanced 'EatRight' dietary intervention among African American women in a workplace setting. Related works: Zunker et al. (2008)	Study design: Sequential, control to intervention cross-over design. Participants: Trial participants (n = 37) with baseline age of 47.5 (11.8) years Other stakeholders: African American women (n = 14) took part in focus groups to inform the research [35]. Setting: Workplace, USA. Time of study: 2006.	Participation method: Iterative intervention development and pilot testing. Data collection techniques: Nominal Group Technique group discussions, iterative intervention development. Data analysis techniques: Thematic analysis.	Assess background knowledge and evidence, pilot/real-world testing.
De Brito-Ashurst et al. (2013): Describe a theoretical approach to inform the development of a nutrition education programme for adult UK-Bangladeshi chronic kidney disease (CKD) patients. Related works: De Brito-Ashurst et al. (2009), De Brito-Ashurst et al. (2011)	Study design: Descriptive Participants: Bengali origin, renal disease patients who participated in a program pilot (n = 6). Age of participants was not reported. Other stakeholders: Interpreters, Bengali key workers and local community dietitians; focus group participants (n = 20). Setting: East London. UK Time of study: Not reported.	Participation method: Intervention mapping and PRECEDE approach. Data collection techniques: Literature review, focus groups Co-design data analysis techniques: Not reported.	Assess background knowledge and evidence, assess user needs to inform intervention focus
Franco et al. (2013): To conduct impact evaluation of activities to promote fruit and vegetables (FV) consumption in the workplace.	Study design: Before-after. Participants: Workers who had lunch in the workplace cafeteria during the study, n = 197 (mean age = 40 (8.3) years). Other stakeholders: Concessionaire owner and nutritionist. Setting: workplace in Rio de Janeiro, Brazil. Time of study: 2007–2009	Participation method: Focus groups to inform intervention design. Data collection techniques: Focus groups, intervention development considering stakeholder preferences/needs. Data analysis techniques: Not specified.	Assess background knowledge and evidence, assess user needs to inform intervention focus, pilot/real-world testing
Hemmingsson et al. (2012): To evaluate weight loss and the dropout rate after a 1-year commercial weight loss program	Study design: Observational cohort study. Participants: Enrolled customers in a weight loss program with a mean age of 48 ± 12 years (range: 18–81 years) Other stakeholders: None reported. Setting: Sweden. Time of study: Not reported.	Participation method: Tailoring of intervention to participants' health goals, food preferences, and nutritional requirements. Data collection techniques: Interview/discussion between participant and health coaches. Decision was based on baseline BMI,	Assess user needs to inform intervention focus

		desired weight loss, and personal preference. Data analysis techniques: Not specified.	
Hernandez et al. (2014): To evaluate the effects of a diet high in total carbohydrate (higher-complex, lower glycaemic index [GI]) and minimal fat on control of maternal glycemia and postprandial lipids. Related works: Hernandez et al. (2016)	Study design: Quantitative (Randomised crossover trial) Participants: Women with diet-controlled gestational diabetes mellitus (GDM), n = 16, 28.4 ± 1.0 years. Other stakeholders: None reported. Setting: University Hospital, Kaiser Permanente Colorado Institute; Colorado, USA. Time of study: Not reported.	Participation method: Tailoring of intervention to participants' health goals, food preferences, and nutritional requirements. Data collection techniques: Food frequency questionnaire completed to establish calorie requirements for individual participants. Data analysis techniques: Descriptive.	Assess user needs to inform intervention focus
Hiel et al. (2019): To evaluate the impact of daily consumption of inulin-rich vegetables on gut microbiota, gastrointestinal symptoms, and food-related behaviour in healthy individuals.	Study design: Quantitative—single group-design trial Participants: Healthy adults (n = 25) aged 21.84 ± 0.39 years Other stakeholders: None reported. Setting: Université Catholique de Louvai, Belgium. Time of study: Not reported.	Participation method: Tailoring of intervention to participants' previous intake/acceptability of vegetables. Data collection techniques: Food diaries, fasting breath samples, visual analogue scales, stool samples. Data analysis techniques: Not specified	Assess user needs to inform intervention focus
Jacobsson et al. (2012): To examine the impact of active patient education on gastrointestinal symptoms in women with a gluten-free diet.	Study design: Quantitative (Randomised controlled trial) Participants: Women with coeliac disease (n = 106), mean age = 53 years, range = 23–80 years Other stakeholders: PBL expert supervised instructors. Setting: Hospitals, Southeast Sweden. Time of study: Not reported	Participation method: Problem-based learning. Data collection techniques: Weekly meetings in groups of 7–9 persons conducted by a tutor familiar with PBL, self-report questionnaires. Data analysis techniques: Not specified.	Assess user needs to inform intervention focus, develop intervention content
Kim et al. (2013): To translate and validate a culturally modified DASH for Koreans (K-DASH) and gather preliminary evidence of efficacy.	Study design: Mixed methods with pre–post intervention evaluation design. Participants: Korean Americans (n = 30), mean age = 55.3 (6.8) years Other stakeholders: Clinicians; community health workers were involved in group education sessions. Setting: Centrally located community-based organisation, The Korean Resource Centre, in the Baltimore-Washington metropolitan area, USA. Time of study: 2011	Participation method: Community-based participatory action research. Data collection techniques: Needs analysis, review of evidence, focus groups, pre–post intervention evaluation. Data analysis techniques: Not specified	Assess user needs to inform intervention focus, pilot/real-world testing.
Madjd et al. (2016): To compare the effect of high energy intake at lunch with that at dinner on weight loss and cardiometabolic risk	Study design: Quantitative (Randomised clinical trial) Participants: Overweight or obese women (n = 80), 18–45 years. Other stakeholders:	Participation method: Tailoring of intervention to participants' food diaries and preferences. Data collection techniques:	Assess user needs to inform intervention focus

factors in women during a weight loss program	None reported Setting: NovinDiet weight loss clinic, Iran. Time of study: Not reported.	Anthropometric measurements, blood samples. Data analysis techniques: Not specified.	
Mosher et al. (2013): To examine whether changes in self-efficacy explain the effects of a mailed print intervention on long-term dietary habits among breast and prostate cancer survivors.	Study design: Quantitative (Randomised trial) Participants: Diagnosed with early-stage breast or prostate cancer within the prior nine months (n = 543), mean age = 57.2 (10.7) years Other stakeholders: None reported. Setting: Community-based; North America. Time of study: Not reported	Participation method: Tailoring of intervention content to participants' current diet and physical activity behaviours and other factors. Data collection techniques: Diet History Questionnaire, 7-day Physical activity Recall, self-efficacy. Data analysis techniques: Descriptive	Assess user needs to inform intervention focus
Nybacka et al. (2017): To examine the effects of diet and exercise interventions on metabolic profile and cardiovascular risk factors women with polycystic ovary syndrome (PCOS)	Study design: Quantitative (Randomised controlled trial) Participants: Women with PCOS (n = 57) 18–40 years Other stakeholders: None reported. Setting: Women's Health Research Unit, Karolinska University Hospital, Stockholm, Sweden. Time of study: Not reported	Participation method: Tailoring of intervention to suit participants' individual nutritional requirements and food preferences. Data collection techniques: Self-reported food intake, pedometer, fasting blood test, DEXA scan. Data analysis techniques: Not specified.	Assess user needs to inform intervention focus
Rudel et al. (2011): To evaluate the contribution of food packaging to exposure to Bisphenol A (BPA) and bis(2-ethylhexyl) phthalate (DEHP) chemicals used in food packaging.	Study design: Quantitative (Quasi-experimental pre–post design) Participants: Family members with exposure to BPAs (e.g., consumed canned foods): n = 20. Median age of the 10 adults was 40.5 years, median age of the 10 children was 7 years. Other stakeholders: Caterer. Setting: Community-based, San Francisco Bay Area, USA. Time of study: Not reported	Participation method: Stakeholder input into menu design. Data collection techniques: Urine samples, daily phone calls with research staff, food questionnaires. Data analysis techniques: Not specified	Assess user needs to inform intervention focus
Shahar et al. (2012): To develop nutrition education materials to promote healthy aging and reducing risk of chronic diseases in older adults living in a rural area.	Study design: Qualitative (Participatory Action Research) Participants: Older adults (≥60 years old; n = 33); Health professionals, e.g., rural clinic staff, physicians, medical assistants, nurses (n = 14) with a mean age of 30.9 ± 8.3 years. Other stakeholders: A professional artist; dietitians, nutritionists, public health physicians and anthropologist. Setting: Health clinics in Klang Valley, Malaysia. Time of study: Not reported	Participation method: Three stage-approach: Needs assessment, intervention development, evaluation (prototype testing). Data collection techniques: self-administered questionnaire. Data analysis techniques: Descriptive analysis.	Prototype testing

Uddin et al. (2017): To develop and test a mobile phone-based system to improve health, population and nutrition services in rural Bangladesh and evaluate its impact on service delivery.	Study design: Quantitative (Quasi-experimental pre–post design). Participants: Target population: currently married women of reproductive age. Other stakeholders: Service-delivery personnel, health, and planning officers. Setting: two administrative divisions of Bangladesh. Time of study: Not applicable.	Participation method: Intervention designed with input (feedback) from stakeholders. Data collection techniques: Surveys. Data analysis techniques: Not specified.	Assess user needs to inform intervention focus, pilot/real-world testing

In summary, community diet interventions employ a range of metrics and methodologies to evaluate participant experience, encompassing participant surveys, focus groups and interviews, participant observations, behaviour change assessments, and process evaluation metrics, to enable comprehensive evaluations of intervention effectiveness and inform strategies for program improvement and refinement. Table 47 displays resources and toolkits informing measures and metrics linked to client experience of interventions.

Table 47. Resources and toolkits for client experience measures and metrics

Source	**Description**	**Link**
Local Government Association Population Intervention Triangle toolkit	Place based approaches for addressing health inequalities, material developed by the LGA and Public Health England	Population Intervention Triangle toolkit | Local Government Association
NHS Dumfries & Galloway, Evaluation Toolkit: For Public Health and Related Activity:	This toolkit has been designed and written to help Public Health professionals to undertake high quality evaluations of current and proposed work. Good quality evaluation is vital to Public Health work but often small changes to evaluation planning and implementation could lead to great improvement in the quality of the output	Evaluation Toolkit: For Public Health and Related Activity (nhsdg.co.uk)
Health Improvement Scotland (HIS) Participation Toolkit	The Participation Toolkit suggests a range of tools, guidance and resources which can be useful for planning community engagement.	Participation Toolkit | HIS Engage
Clinical Trials Ontario Participant Experience Toolkit	Participant surveys may improve trials through collecting and implementing feedback from participants in the trial. Surveys may be implemented at different time points, including pre-study, mid-study, and post-study. If surveys are implemented, it is important that feedback will be used in a meaningful way to improve the study and its processes.	Participant Experience Toolkit - Experience Surveys (ctontario.ca)
Young Minds: Evaluating Participation: A guide for professionals	This toolkit was created as part of the Amplified project run by YoungMinds and commissioned by NHS England. Amplified is a programme that aims to support the participation of children, young people and their families at every level of the mental health system	evaluating-participation-toolkit.pdf (youngminds.org.uk)

Revolving Doors: TOOLKIT: DEVELOPING A COMMUNITY OF PRACTICE	This is a toolkit for all those who are interested in establishing communities of practice for frontline practitioners in health, housing, criminal justice and social care agencies.	Toolkit-for-developing-a-community-of-practice.pdf (revolving-doors.org.uk)
West Lothian Council Engaging Communities Toolkit	This Community Engagement Toolkit brings together a range of introductory information on community engagement. It has been designed as a practical resource for anyone who wants to learn more about what we mean by engagement; providing practical guidance on the issues to consider when planning and designing community engagement activities.	Engaging Communities Toolkit.pdf (westlothian.gov.uk)
University of Reading Participatory Action Research: A Toolkit	This toolkit is for community researchers, community organisations, students and academics who want to reflect on and better understand: • The principles and everyday practices of PAR • Building community research teams • Using PAR to understand local issues.	Participatory Action Research: A Toolkit (reading.ac.uk)
Scottish Government Participatory engagement and social research: methods toolkit	A toolkit of methods available to assist developers, consultants, and researchers carrying out socio-economic impact assessments (SEIA).	Participatory engagement and social research: methods toolkit - gov.scot (www.gov.scot)
Garmager et al., (2022)	Integrating user experience evaluation in the development of a web-based Community Engagement Toolkit	Integrating user experience evaluation in the development of a web-based Community Engagement Toolkit - ScienceDirect

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