

Review

The combined use of quantitative and qualitative longitudinal methods in the study of obesity

Cecilia Díaz-Méndez^{a,*}, Jean Adams^b^a Department of Sociology, University of Oviedo, Oviedo, Spain^b Centre for Diet & Activity Research, MRC Epidemiology Unit, University of Cambridge, Cambridge, United Kingdom

A B S T R A C T

Keywords:

Longitudinal studies
Obesity
Physical activity
Methods
Evaluations studies

Objective: To explore the combined use of quantitative and qualitative methods with a longitudinal perspective in the field of obesity diet and physical activity.

Method: A systematic scoping review following PRISMA guidelines. The databases searched were Web of Science, PubMed, and ASSIA.

Results: 1592 records were returned from the searches. In total, nine studies met the inclusion criteria and were included in the review. Authors of included studies mixed quantitative and qualitative methods to obtain a deeper understanding of their study subjects, but few documents use longitudinal data. Authors value the combination of methods and try to integrate the results in their conclusions.

Conclusions: Total integration is rarely achieved in the analysis. The origin of this divergence can be found in the lack of theoretical guidance in these articles, but also in the difficulty of working in multidisciplinary teams in the field of obesity.

© 2020 SESPAS. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Métodos longitudinales cuantitativos y cualitativos en el estudio de la obesidad

R E S U M E N

Palabras clave:

Estudios longitudinales
Obesidad
Actividad física
Análisis cuantitativo
Análisis cualitativo

Objetivo: Explorar el uso combinado de métodos cuantitativos y cualitativos con una perspectiva longitudinal en el campo de la obesidad y la actividad física.

Método: Se ha realizado una revisión sistemática de las bases de datos Web of Science, PubMed y ASSIA siguiendo las pautas de PRISMA.

Resultados: Solo nueve estudios fueron seleccionados de los 1592 que cumplieron los criterios de inclusión. Los autores combinan métodos cuantitativos y cualitativos, y afirman hacerlo para obtener una comprensión más profunda de sus sujetos de estudio, pero pocos utilizan datos longitudinales. Se valora la combinación de métodos y se intenta integrar los resultados en las conclusiones.

Conclusiones: La integración total de métodos cuantitativos, cualitativos y longitudinales es excepcional y rara vez se logra en el análisis de los resultados. El origen de esta divergencia se puede encontrar en la falta de orientación teórica de estos artículos, pero también en la dificultad de trabajar en equipos multidisciplinarios en el campo de la obesidad.

© 2020 SESPAS. Publicado por Elsevier España, S.L.U. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

The alarming increase in the prevalence of obesity worldwide has led to substantial academic and policy interest and action.^{1–4} Obesity is a complex phenomenon with many determinants in both the social and biological realms that are likely to act independently, in series, and synergistically in both predictable and unpredictable ways.^{1,5–8} The importance of both biological and social factors in the etiology of obesity has led to many calls for inter-, multi- and even transdisciplinary working between those with training in the social and natural sciences, and beyond, in order to achieve a

comprehensive understanding of both the ‘problem’, and potential solutions.^{8–11} In addition to different disciplines working together, the combined use of qualitative and quantitative methods and the integration of these different methodological approaches has been widely suggested.^{12–14} This is known as ‘mixed methods’ research.

Mixed methods research has been widespread in the field of nursing and medicine since the 1990s.^{13–17} A key benefit of mixed methods research is the potential to integrate findings from different methodological approaches.¹⁸ The use of mixed methods has been repeatedly proposed as an effective approach to frame and solve complex problems like obesity.^{7,19} Both approaches are necessary to the study of a multicausal phenomenon such as obesity.

We are aware of a number of previous systematic reviews that have focused on mixed methods designs in the health field¹⁷ and which have combined primary quantitative and qualitative studies

* Corresponding author.

E-mail address: cecilia@uniovi.es (C. Díaz-Méndez).

on obesity-specific topics.^{20–22} However, we are not aware of any previous systematic reviews of longitudinal, mixed methods studies specifically related to obesity. Given the public health importance of obesity, and the potential value of both longitudinal and mixed methods approaches to developing a full understanding of obesity, we conducted a systematic scoping review of longitudinal, mixed methods studies in the field of obesity and its primary behavioural determinants—diet and physical activity. Our primary aim was to understand how longitudinal mixed methods have been used in this field, rather than the findings of these studies. Scoping reviews allow literature to be mapped in this way without a focus on findings.

In most previous reviews of mixed methods, authors have considered cross-sectional quantitative and qualitative methods but we don't have information about the mixed-use of qualitative and quantitative longitudinal data. From a quantitative point of view, a longitudinal perspective allows for better estimation of causal inference and the exclusion of the possibility of causality associated with cross-sectional data. From a qualitative point of view, a longitudinal perspective allows a greater understanding about the impact of previous experiences on present actions.

Methods

Inclusion criteria

We searched for primary research papers that simultaneously reported longitudinal data collected using both quantitative and qualitative methods in the fields of diet, physical activity and obesity. Following Morse and Niehaus we defined longitudinal data as that which “is gathered from the same subjects repeatedly over a period of time”.²³ We defined qualitative methods as those which used written or spoken discourse as the data.²⁴ We defined quantitative methods as those which use numbers as the basis for making generalizations about a phenomenon.²⁵

In order to capture work on “obesity” in its widest sense, we included studies that focused on diet and physical activity as both social and biological concepts directly linked to obesity. We excluded studies focusing on hospitalized populations, populations with chronic illnesses, and diseases or treatments which affect patients' diets (e.g. chemotherapy or anorexia). However, we included papers related to community-dwelling (not hospitalized) individuals with type 2 diabetes. We also excluded studies of populations with unusual relationships to food and physical activity, including those in residential care, and professional sportspeople. However, we included studies which included healthy pregnant women or focused on breastfeeding. We did not impose any restrictions based on year or language of publication.

Search strategy

We searched for papers meeting the inclusion criteria in three databases covering both social and natural health sciences: Web of Science, with access to multidisciplinary databases (<https://clarivate.com/products/web-of-science/databases/>); PubMed, with citations for biomedical literature from MEDLINE (US National Library of Medicine), life sciences journals and on line books; and Applied Social Sciences Index and Abstracts (ASSIA).

The search was conducted in August–September 2017. The search terms were: qualitative AND (longitudinal OR cohort OR prospective OR retrospective OR epidemiology) AND (food OR eat OR diet OR Obese OR obesity OR BMI OR overweight OR adiposity OR “Physical activity” OR sport OR exercise OR sedentary).

In Web of Science we used the Core Collection, filtered for peer review and articles and included abstracts, titles and keywords. In

PubMed, we filtered by “Human” studies (not animal), free full text and peer review and only open access documents. And in ASSIA we filtered by peer review.

Screening

Firstly, we remove duplicates and then screening titles and abstracts. Full texts for remaining records were then retrieved and screened following inclusion criteria.

Data extraction

The included studies were organized in four categories using a data extraction template. Firstly, we extracted general information about the study topic, objectives, and study participants. Secondly, methodological aspects were captured including how authors' described mixed methods, details of sampling, sample recruitment, and data collection. Finally, analytical and integration methods and study limitations identified by authors were recorded. Data were tabulated for analysis and were narratively synthesized (reporting results according to PRISMA).

Results

After removal of duplicates, 1592 records were returned from the searches. In total, nine studies met the inclusion criteria and were included in the review. The flow of studies through the review and the reasons for exclusions are detailed in [Figure 1](#).

Thematic areas

The main focus of included papers, their objectives and study populations are described in [Table 1](#). Seven out of nine papers were focused on diet, whilst two referred to physical activity. Within the nine papers focused on diet, one¹ focused in particular on food insecurity.

Given our restriction to longitudinal data, it is not surprising that all included papers studied change over time. However, both observational and interventional approaches were included with two papers exploring the effect of interventions on eating habits²⁷ and physical activity.²⁸ The remaining studies focused on change over time in the absence of a researcher-led intervention, but sometimes in relation to a change in life circumstances, such as the arrival of a new child.^{26,29–33} Two studies tested technologies that aimed to improve eating habits. Morrison et al.³¹ studied a mobile application implementation of a weight control program; and Whitford et al., used text messages to influence newborn feeding patterns. Three included studies focused on university students.^{30–32} The remaining six articles studied mothers with children,^{29,33,34} women in general²⁸ and families.^{26,27}

The use of methods

Six out of nine papers explicitly referred to the value of mixed-methods methodologies and identified this as a particular strength of their work ([Table 2](#)). The majority of authors referred specifically to the advantages of qualitative approaches and proposed that their qualitative results provided more information and deeper knowledge than their quantitative ones.^{26,28,31–33} In addition, three articles mentioned the advantages of the longitudinal perspective to developing evolving understanding over time.^{30,31,34}

Many authors also identified limitations of qualitative techniques. In particular, the limits imposed on generalizability of small sample sizes.^{26–28,31,34} The samples used in most included studies were small and unrepresentative in probabilistic terms, but clear

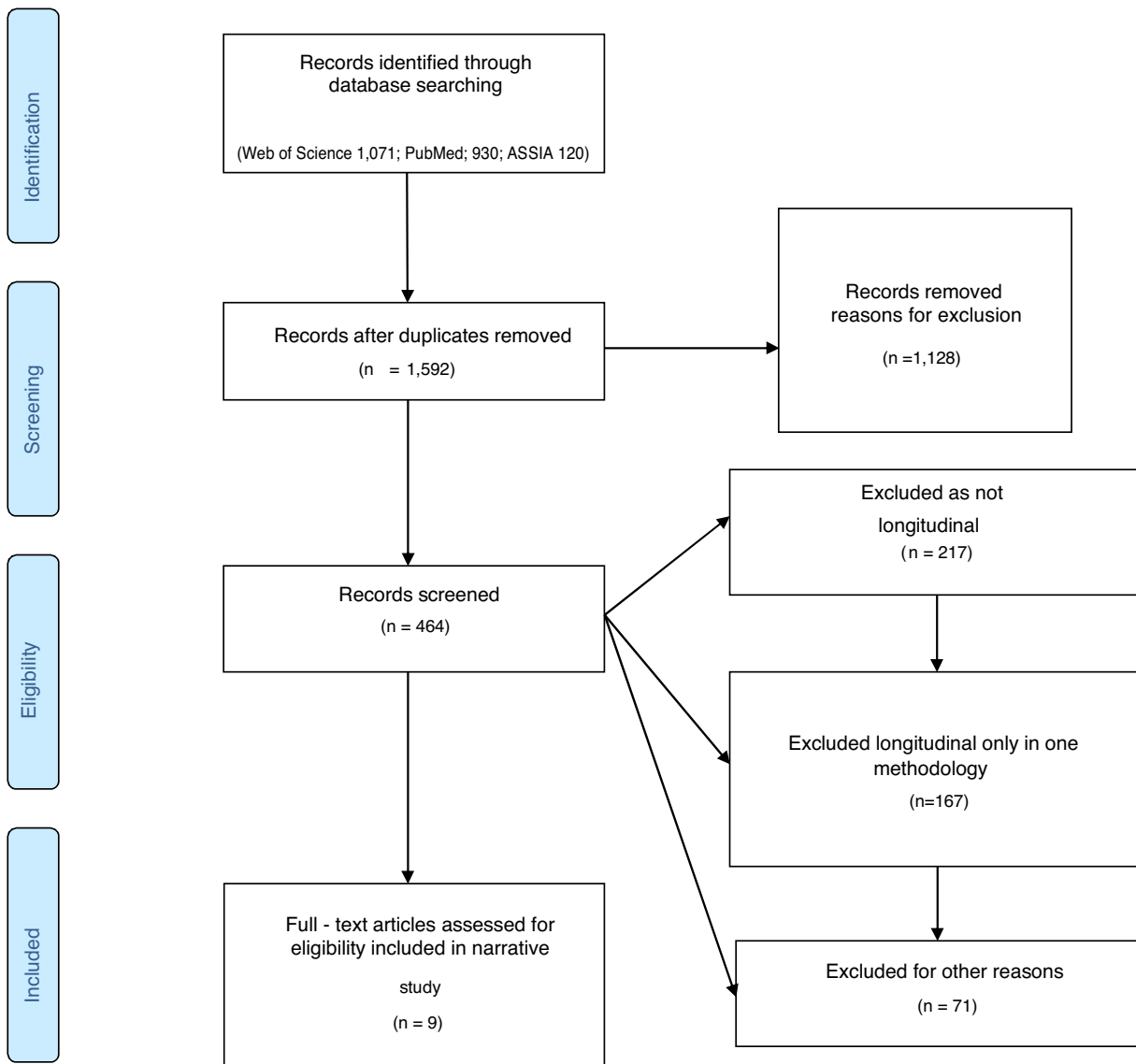


Figure 1. Search results according to PRISMA.

sampling strategies were provided. Purposive sampling was used in four studies.^{26,30,32,34}

Two of the studies used convenience samples of participants in intervention programs who agreed to take part in an additional qualitative component.^{28,31} However, in the case of Morrison et al.³¹, recruitment ceased when saturation was achieved. As well as small sample sizes limiting generalisability, Morrison et al.³¹, also identify the limitation imposed by using student volunteers on generalisability.

In other cases, participants were randomly selected from those taking part in a controlled trial. This is the case of the 57 parents of the study by Gardner et al.²⁷. Whilst this may also be the case in Whitford et al.³³ details of selection beyond being part of the main study are sparse. Only one of the studies had a sample size sufficient to be statistically representative of the population.²⁹

Following the mixed methods typology of Johnson et al.¹² five of the nine included articles used a dominant quantitative model, one a dominant qualitative model, and three gave both methods the same weight. Qualitative data was obtained from in-depth interviews or from open survey questions. In five cases both open and closed survey questions were

used.^{26,29,32–34} In three cases, in-depth interviews accompanying a survey.^{27,28,31,33}

One article used focus groups in addition to open survey questions to generate qualitative data, but the same participants did not take part in both methods.²⁹ One paper presented a case study.³⁰ Only one article used different samples for their quantitative and qualitative components complementing their quantitative data with qualitative interview data.³⁰ The remainder used the same participants in both the quantitative and qualitative components, with both open and closed survey questions asked of the same subjects. Whilst this offers more information about the same subjects, the authors themselves point out that the depth of the results is reduced.

All included articles provided separated descriptions of their approach to both qualitative and quantitative analysis. All of them included verbatim quotations to illustrate qualitative results.

Quantitative descriptive analyses were used in all cases, with standard statistical procedures used in a variety of ways.

Most authors referred to coding and thematic analysis in qualitative approaches. Some explained how consensus was achieved when arriving at the final coding scheme,^{26,28}.

Table 1
Focus, subjects and objectives of included studies.

Authors, year and country	Main focus	Subjects of study	Objective
Carruth and Skinner, 2000 (USA)	Children and unfamiliar food. Problem eaters or picky eaters.	Mothers whose children were participating in an ongoing longitudinal study from 2 to 96 months of age.	The objective is to compare picky eater behaviors (food neophobia) of children as toddlers and to assess their mothers' neophobic behaviours.
Duong et al., 2005 (Vietnam)	Determinants of breast-feeding.	Rural women who gave birth during August–October 2002.	This study explores factors influencing breast-feeding practices within the first 6 months post-partum among women residing in the rural northern region of central Vietnam.
Duram and Williams, 2015 (USA)	To promote the adoption of sustainable agriculture Univeristary education Interaction with stakeholders.	University students initiated in the organic garden in the campus.	The purpose of this paper is to examine the evolution of a student organic garden at a large public university, as an example of student initiatives that promote both campus sustainability and student-focused sustainability education on campus.
Gardner et al., 2014 (UK)	Learning and maintaining food habits. Changes in food habits in children. Program "Healthy Feeding Habits". Child-feeding habit Food consumption n children: fruit and vegetables, water, healthy snacks.	Parents of children aged 2-6 years.	This study used process evaluation data, taken from a randomised controlled trial of a health child-feeding intervention for parents previously shown to be effective (Healthy Feeding Habits), to explore the applicability to dietary behaviour change of predictions and recommendations drawn from habit theory.
Huberty et al., 2013 (USA)	To maintain physical activity in woman "Woman Bound to be Active" Program.	Women, 19 years or age or older, who had participated in the second pilot intervention of the "Women Bound to the Active" Program.	This study used a longitudinal mixed –methods approach to determine the effectiveness of an 8 month book club intervention for increasing physical activity participation and self-worth, and reducing barriers at 1 year follow up; and to indentify reasons why completers and non completers did not maintain psychical activity.
Morrison et al., 2014 (UK)	Mobile phone technology (Apps) and health behavior change interventions The use of smartphone in health.	Volunteer university students.	This study used a novel mixed-methods design to examine the impact of, usage, and views of a weight management app (POWeR Tracker "Positive Online Weight Reduction") that was provided alongside a Web-based weight management intervention.
Moy et al., 2014 (Australia)	Education in Physical Activity at school Physical Education Teacher Education (PETE) Program. Education teaching practice. Alternative pedagogy.	First year university students with competitive games playing background.	To investigate whether past school and sporting experiences are powerful influences on Australian Physical Education Teacher Education (PETE).
Olson et al., 2007 (USA)	Poverty and food deprivation In childhood. Childhood food deprivation and obesity in the later life. Relationship between low socioeconomic status in childhood and obesity in the adult years.	Rural families with a mother who was at least 18 years-old, with at least one child 12 years of age or younger living with her, and an annual household income of less than 200% of the federal poverty level.	The objective was to gain an understanding of how poverty-associated food deprivation in childhood might influence attitudes toward and the use of food in later life.
Whitford et al., 2012 (UK)	The use of message service (SMS) for collecting research data. Feeding method. Attitude feeding.	Recently delivered women in Tayside, Scotland, UK.	To test the reliability, validity, acceptability, and practicality of short message service (SMS) messaging for collection of research data about current infant feeding method and future feeding plans.

Quality assessment

According to the objective of the review and the potential of mixed methods research to integrate findings from different methodological approaches¹⁸ we assessed the quality of papers. We did this by exploring the degree of results integration explained and the authors assessment of mixed and longitudinal methods used. The articles show a very variable degree of joint analysis and integration of results. Most included articles presented qualitative and quantitative results separately in different sections and in different tables; only Gardner et al.²⁷ presented tables combining qualitative and quantitative data. A clear example of integration is joint report of the quantitative and qualitative results in the discussion section of article. This occurred in all included articles, although with differing intensities

given the differing dominance of quantitative and qualitative approaches.

Authors (Table 3) justified the use of mixed methods as the most appropriate way to achieve their objectives. In seven of the nine articles, the authors proposed that the use of mixed methods improved their work by providing deeper knowledge of study subjects and more comprehensive explanations of quantitative results. They argue, as previously,²¹ that mixed methods create stronger results than achievable via a single method. Two articles included specific reference to the advantage of a longitudinal perspective.^{30,34} They argue that this allows knowledge of how study subjects evolve over time and thereby helps identify potential intervention points that could not be known otherwise.

Whilst all authors present and analyse qualitative and quantitative results together in their discussion sections, none of

Table 2
Data collection and sampling methods of included studies.

Authors, year and country	Reference mixed methodology in objectives ^a	Methodology	Sample recruitment ^a	Qualitative techniques (sample)	Quantitative techniques (sample)	Type of sampling
Carruth and Skinner, 2000 (USA)	-	Interviews with mothers when their children were 42, 60, 72 and 84 months of age. Mothers reported children's diets and their behaviors; weight and height were measured. Nutritionist IV software, correlations, t tests and repeated measures ANOVA were used to determine nutrient intake, behavioural relationships and differences by picky eater status. Mothers' descriptions of the children's food neophobia and bothersome behaviors were analyzed by qualitative methods.	The sample was purposively recruited to study children in a home environment which was characterized by educated parents, adequate food availability and access to health care.	Questionnaire with open-ended questions (n = 71)	Questionnaire with close questions (n = 71)	Purposive sampling. Same sample for QL and QT
Duong et al., 2005 (Vietnam)	Using a combination of qualitative and quantitative methods, this study explores factors influencing breast-feeding practices	The study have two phases: 2002 and 2003. In the first phase, 463 women were prospectively studied at weeks 1, 16 and 24 post-partum. In the second phase, 16 focus group discussions were undertaken two times (May to June 2004).	Statistic representativeness in quantitative part. The subjects were consecutively selected until the required sample size for sufficient statistical power (80%) was attained	Focus group (n = 16 groups) Open questions in the survey (n = 463)	Survey (n = 463) Statistical representatives of the studied population	Probability sampling. Same sample for QL and QT in survey. Questionnaire with open and close questions.
Duram and Williams, 2015 (USA)	This paper provides a longitudinal perspective on the evolution of student-led sustainability efforts.	This three-year study employed a mixed-method approach to assess Local Organic Gardening Initiative, the university student organic garden. Beginning in early 2009, data were collected from public sources and univariate quantitative analysis of budget information and volunteer data was undertaken to provide a baseline understanding of the garden. Interviews with nine key participants were conducted and analysed to develop an understanding of the past, present, and future of Local Organic Gardening Initiative	Data were collected from public sources and univariate quantitative analysis of budget information and volunteer data was undertaken to provide a baseline understanding of the garden.	Case of study Indeed interviews: staff, faculty, Interviews (n = 9)	Case of study Questionnaire about the garden Secondary sources: Collected data about funding, hours, harvest, plants, . . .	Convenience sampling. Different sample Case of study QL ethnography.
Gardner et al., 2014 (UK)	-	Qualitative and quantitative data were taken from 57 parents randomised. Thematic analysis of post-intervention qualitative interviews. The 'Healthy Feeding Habits' intervention comprised four, hour-long home visits. The study was conducted, post-hoc, to maximise the information gleaned from the intervention trial. Three habit formation goals – one for each feeding behaviour – were staggered over six weeks, with participants beginning to pursue one goal at baseline and choosing an additional habit goal at second and third visits, two and four weeks later.	Participants randomized as part of a controlled trial.	Semi-structured interviews with parents (n = 57)	Questionnaires self-reporter with parents (n = 57) Quantitative habit and behavior measures (in person or via phone call)	Random sampling. Same sample QL and QT

Table 2 (Continued)

Authors, year and country	Reference mixed methodology in objectives ^a	Methodology	Sample recruitment ^a	Qualitative techniques (sample)	Quantitative techniques (sample)	Type of sampling
Huberty et al., 2013 (USA)	This study used a longitudinal mixed-methods approach to 1) determine the effectiveness of an 8-month book club intervention for increasing physical activity participation and self-worth, and reducing barriers at 1-year follow up; and 2) identify reasons why completers and noncompleters did or did not maintain PA	The follow-up study of the Woman Bound to be Active programme (WBA) one year after the cessation. Interview (questionnaire) women who completed the program (n = 30) and women who did not complete the program (n = 22).	Volunteer recruitment. Participants were originally recruited in WBSA program through newspaper advertisements, volunteered to participate, and paid.	Qualitative Interviews via phone (3 times) (n = 30+22)	Surveys: questionnaires. Demographics questionnaires. Physical activity questionnaire. Benefits to barriers ratio scale. Self-worth scale. (n = 30+22)	Convenience sampling. Same sample in QL and QT
Morrison et al., 2014 (UK)	This study points to the value of using a mixed-methods approach to understand how individuals use and view app-based delivery of health behavior change interventions. The development of smartphone-based health interventions (apps) is a rapidly growing field of research, yet there have been few longitudinal examinations of how people experience and use these apps within their day-to-day routines, particularly within the context of a hybrid Web- and app-based intervention.	Personal eating and physical activity plans and goals during the first 3 Web-based sessions of the POWeR intervention. 3 complete sessions in the web page and self-report measures and goal engagement (daily questionnaires) every day for all 4 weeks of the study via the POWeR Tracker app. Semistructured telephone interviews were conducted at the end of each week to discuss each participant's experiences of using POWeR and POWeR Tracker.	Volunteer recruitment. A volunteer sample of 13 participants was recruited using paper-based advertisements placed around the campus of the University. Recruitment ceased when no substantially different insights of participants' experiences of POWeR Tracker were derived (i.e., when saturation was achieved).	Semi structured interview telephone (n = 13)	Self-reported daily questionnaires (different measures) (n = 13)	Convenience sampling. Same sample n QL and QT
Moy et al., 2014 (Australia)	-	First year physical activity university students (PETE) (n = 49). Prior to the commencement of the unit participants completed part A of a two part mixed response questionnaire aimed at gathering data about their physical education and sporting background. Students experienced the constraints-led approach as learners and teachers during an 8-week games unit. Pre and post intervention, participants completed part B responding, via Likert Scale with their opinion about games teaching session. This resulted in a traditional reproductive games teaching belief score.	Participants were pre-service PETE students undertaking a compulsory unit on games teaching in 2010. Although students of varying ages and course progressions took the unit, only first year students who had finished school in Queensland within the last five years were chosen for the study, ensuring that this unit would be the student's first practical unit aimed at developing skills in teaching practice. The study sample (n = 49) consisted of an approximately equal gender breakdown (53% male, 47% female) with a mean age (18.88 + 1.57 years) representative of a typical PETE cohort at a university in Queensland. All participants in the sample had an extensive competitive games playing background and were grouped according to their self-reported highest level of representation in games; To confirm accuracy of the researchers' classification of participants into groups, an independent expert also classified the participants and agreement was reached on 100% of the sample.	Questionnaire with open questions before and after the game. (n = 49) (schools clubs n = 13; regional n = 20; national = 16)	Questionnaire with close response before and after the game. (n = 49)	Purposive sampling. Same sample in QL and QT

Table 2 (Continued)

Authors, year and country	Reference mixed methodology in objectives ^a	Methodology	Sample recruitment ^a	Qualitative techniques (sample)	Quantitative techniques (sample)	Type of sampling
Olson et al., 2007 (USA)	This study used a triangulation mixed-methods design, collecting both quantitative and qualitative data, analyzing them separately, and then comparing and combining results to address the research objective.	Annual semi-structured interviews collecting quantitative and qualitative data from 30 low-income, rural women with at least one child. 3 annual waves with closed and open-ended questions with a similar questionnaire, over approximate 4 year period.	This investigation used the New York State data from a large longitudinal multi-state research project, “Rural Low-Income Families: Tracking Their Well-Being and Functioning in the Context of Welfare Reform” (Rural Families Speak, 2002). The research protocols for the multi-state study dictated the characteristics of the sample and the basic questionnaires used for data collection. Eligibility criteria for inclusion of the family in the sample were the following: a mother who was at least 18 years-old, with at least one child 12 years of age or younger living with her, and an annual household income of less than 200% of the federal poverty level. In New York State, participants were recruited through programs that serve low-income families and by referral from other study participants. Sampling was purposive and designed to capture the diversity in characteristics of poor mothers in rural counties in Upstate New York.	In-depth, personal interviews Questionnaires with both closed- and open-ended questions. (n = 30 families) Notes and observations.	Close questions in in-depth interview (n = 30 families) US Household Food Security Survey Module	Purposive sampling. Same sample in QL and QT
Whitford et al., 2012 (UK)	Acceptability was evaluated using quantitative and qualitative questions, and practicality by analysis of a researcher log.	After delivery, women were followed up by SMS text messages every 2 weeks to ascertain their current feeding method. The answers to SMS messages were compared. Comparison between text questions (qualitative and quantitative) and phone questions and the same data collected from other sources. Interview at the end of the research asked about their experiences of infant feeding.	Randomized in a controlled trial. Women were recruited to the main study to ascertain their attitudes to infant feeding and feeding plans during pregnancy. Three distinct convenience samples were drawn from a mainly urban population of women enrolled in the main study who were receiving text messages asking about infant feeding method and intentions.	Qualitative comment at the end of the telephone questionnaire and internet message (329 messages) Subsamples for Reliability (n = 48 and n = 68), validity (n = 62) and acceptability (n = 74)	Internet messages (n = 329)	Same sample QL and QT Questionnaires with open and close questions

^a Text literally taken from article.

Table 3
Analytical and integration methods, and methodological limitations, of included studies.

Authors, year and country	Type of qualitative analysis	Type of quantitative analysis	Methodological integration	Methodological references in discussion and conclusion (authors comments)	Methodological limitations (authors comments)
Carruth and Skinner, 2000 (USA)	Thematic analysis (verbatim)	Descriptive analysis. ANOVA Factor analysis	QUAN+ qual Quantitative and qualitative data presented separately in different tables. Data analyzed separately. Joint discussion of results.	Longitudinal data have an inherent strength that measurement of the same group over time. Their environment and development can be monitored to better explain research findings. The objective of the qualitative part is to obtain complementary information	Small sample. No statistical representation.
Duong et al., 2005 (Vietnam)	Codes and list of themes (verbatim)	Logistic regression analysis	QUAN+ qual Qualitative and quantitative results given separately. The results are discussed together in the discussion.		Demographic and Health Survey used a very small sample of children across seven regions of Vietnam, therefore, the resulting rate might not be representative for the rural northern region of central Vietnam.
Duram and Williams, 2015 (USA)	Themes, codes and content analysis (verbatim)	Descriptive analysis	quanti+ QUAL No joint interpretation of qualitative and quantitative data. In the discussion section, a joint interpretation of results is given	The longitudinal perspective offer the opportunity to know the evolution of student-led sustainability efforts. At the same time, offer information for future actions in the multiple stakeholders across campus and in the community.	-
Gardner et al., 2014 (UK)	Thematic analysis Coding framework Iteratively and inductively. (verbatim)	Descriptive analysis Mixed-design ANOVA	QUAL+ QUAN The working sessions of the team for coding are mentioned. The interviews have been conducted and analyzed by a single researcher. Qualitative and quantitative joint results are eported in some tables. Qualitative and quantitative results are discussed together in the discussion.	-	Qualitative data were collected by the same researchers who delivered the intervention, and analyzed by one of these researchers. For this reason participants may have felt pressured to provide positive and socially desirable comments.

Table 3 (Continued)

Authors, year and country	Type of qualitative analysis	Type of quantitative analysis	Methodological integration	Methodological references in discussion and conclusion (authors comments)	Methodological limitations (authors comments)
Huberty et al., 2013 (USA)	Codebook and consensus (verbatim)	Mixed-model repeated-measures ANOVA	QUAN+ QUAL Qualitative and quantitative data are presented separately. Three team members organized the codes and agreed on the interpretation of results. Qualitative and quantitative joint results are offered in the analysis although there are no tables with combined data.	Qualitative interviews augmented quantitative data to better understand why women maintained or failed to maintain physical activity at one year follow-up.	Statistical power was limited for the small sample. Difficulties to detect meaningful differences between completers and non completers the program.
Morrison et al., 2014 (UK)	Inductive thematic analysis (verbatim)	Two mixed effects models Bivariate correlational analyses	QUAN+ QUAL The qualitative and quantitative data are analyzed separately. The interpretation of results is also done separately	Analysis of only the qualitative data may have overemphasized the importance of participants' preferences for appraised delivery of intervention content. Analysis of only the quantitative data would not have provided explanations for why the provision of a supplementary app had a greater impact for some participants compared to others. Longitudinal research can improve our understanding of when, why, and how individuals experience and make use of health apps in their mobile phones, within their daily lives. Qualitative data offer a more in depth knowledge that the results.	Findings from this study are based on a small, predominantly young, and highly educated sample limiting generalizability and statistical power.
Moy et al., 2014 (Australia)	Codes and categories. Content analysis. (verbatim)	ANOVA Tukey's HSD Post Hoc Test Two-tailed, paired-samples t-test. Licker Scales	QUAN+ QUAL Three researchers compare the results provided by participants of both qualitative and quantitative parts. The results of the qualitative and quantitative part are combined, although with scarce references to the latter. Both results integrated in the conclusions are mentioned.		-
Olson et al., 2007 (USA)	Thematic and coding analysis. Comparative method. Iterative process. List of topics. (verbatim)	Descriptive analysis	QUAN+ QUAL Meetings of the research team for coding and analysis. Search for agreements on the topics. Separate presentation of results from both parts of the study. The results are discussed together in the conclusions	The quantitative and qualitative findings are interpreted to address the objective of the study. The mixed methods approach is a strength of this article.	The sample size is small for quantitative analyses but the findings supports the use of this sample for future researches.
Whitford et al., 2012 (UK)	Thematic and coding analysis (verbatim)	Descriptive analysis Cohen's kappa coef. Spearman's corrl.	QUAN+ QUAL Joint elaboration of codes in the qualitative part is mentioned. The results are reported together in the discussion section.	The qualitative comments confirmed the high acceptability and convenience of the method of collecting data by SMS.	-

them refers specifically to the type of methodological integration conducted.¹⁸ However, as confirmed in other reviews¹⁷ conclusions were integrated. No authors mentioned the theoretical orientation adopted in their work, although some mentioned the use of an inductive approach to analysis^{27,31} or that a specific procedure has been carried out to generate hypotheses (e.g. an iterative process).²⁶

Based on the objective of this systematic review, we consider that the quality of the selected articles can be determined by the degree of integration of the research methods used (quantitative, qualitative and longitudinal). Thus, we can affirm that all have achieved a joint discussion of the results, and some integrated conclusions regarding the combined use of qualitative and quantitative methods were presented. However, only two papers^{30,34} extend this discussion to the use of a longitudinal perspective.

Discussion

This work had the objective to explore the combined use of quantitative and qualitative methods with a longitudinal perspective as applied to the study of obesity, diet and physical activity. After review only nine studies were identified that met our criteria. This shows a limited interest (or difficulty) in combining these methodologies. The first observation we experienced was terminological confusion. When screening papers, we found a number of studies that claimed to use qualitative methods, but did not specifically use discursive data. For example, some authors considered attitude items using Likert-type scales as a qualitative methodology. Similarly, we found a number of examples where “longitudinal” was used to refer to repeated cross-sectional designs, rather than data collected from the same participants at different points in time.

The included articles confirm an interest in using mixed methods in order to provide more comprehensive understanding of obesity, diet and physical activity. These methods were used in a longitudinal context particularly to explore intervention effectiveness or behaviour change across life transitions. However, all included articles were published since 2000 suggesting that longitudinal mixed-method approaches are relatively new. Many authors identified that including qualitative components substantially improved the understanding gained from their work. Clearly there is substantial interest in addressing some of the limitations of quantitative methods with the additional use of qualitative methods. But the small number of included studies suggest that we have to search for more explanation for why scientists don't use mixed longitudinal methods.

A key methodological challenge of mixed methods identified by study authors is the limitation on generalisability imposed by small sample sizes. However, this may reflect a mistaken attempt to quantify qualitative results.³⁶ Although some authors solved this problem with targeted recruitment of study subjects, it remains a challenge to collect statistically representative and therefore generalizable data in a mixed methods context. Others used surveys with open and closed questions, in order to include larger sample sizes, but the authors themselves identify that whilst this leads to deeper understanding than quantitative methods alone, it does not achieve the depth of information achieved with more traditional forms of qualitative data.

In most included papers, no reference was made to the type of qualitative analysis performed. Whilst procedures are mentioned (thematic grouping and coding) the inductive or deductive process leading to final interpretation of results is not explained. Qualitative analytical approaches were generally poorly described. In contrast, detailed explanations and justifications for quantitative analysis procedures were consistently provided. These results could show

the distance between quantitative and qualitative paradigms and the dominance of the first over the second.

Our data has a limitation: the searches were conducted in 2017 and we have not updated them. However, we would like to point out that we have consulted the three most widely used databases for the study of obesity by both the health sciences and the social sciences. Also we did not impose any restrictions based on year or language.

In conclusion, our finding shows limited use of mixed longitudinal methodologies in the field of obesity, but where these are used, authors use them to gain deeper understanding of the 'problem' of obesity. There appears to be openness within the health sciences towards the use of mixed methods. In the field of public health, in particular, the use of combined qualitative and quantitative methods is valued.

Given the great transformation of eating habits and physical activity in recent decades and the increasing consideration of obesity as an epidemic, its inclusion as a public health topic is an opportunity for adopting longitudinal qualitative perspectives alongside traditional quantitative epidemiological studies.

At the beginning of the XXI century, a much greater connection between epidemiology and the social sciences was anticipated. Obesity is clearly socially patterned and inherently a social topic incorporating issues of key relevance to the social sciences: poverty, consumption, sports and eating habits, and sustainability. The mixed longitudinal approach is one way to achieve this type of collaboration and a new road to multidisciplinary. One way to address the current paucity of collaboration would be to ask both health and social scientists why they do not currently collaborate and what could be done to support them to do so further.

A limitation of this review is that it could not be updated. However, we would like to point out that we have consulted the three most widely used databases for the study of obesity by both the health sciences and the social sciences. Also, we did not impose any restrictions based on the year and language.

Editor in charge

Gonzalo Casino.

Authorship contributions

C. Díaz-Méndez screened all retrieved records, firstly removing duplicates and then screening titles and abstracts to identify studies that clearly did not meet the inclusion criteria. Full texts for remaining records were then retrieved and screened by C. Díaz-Méndez and J. Adams. Data was extracted from included studies by C. Díaz-Méndez using a data extraction template made by the two authors. Data were tabulated for analysis for C. Díaz-Méndez, and were narratively synthesized in the article by C. Díaz-Méndez and J. Adams. Both authors contributed to the interpretation and gave final approval for submission.

Funding

This work was supported by the Ministerio de Educación, Cultura y Deportes, Gobierno de España, Programa Salvador de Madariaga (Grant Ref. PRX17/00121). Jean Adams is funded by the Centre for Diet and Activity Research (CEDAR), a UKCRC Public Health Research Centre of Excellence which is funded by the British Heart Foundation, Cancer Research UK, Economic and Social Research Council, Medical Research Council, the National Institute for Health Research, and the Wellcome Trust (ref: MR/K023187/1). The funders had no role in the study design, in the collection,

analysis and interpretation of data or in the writing of the report and the decision to submit for publication.

Conflicts of interest

None.

References

- Long B, Robertson A. Obesity and inequities. Guidance for addressing inequities in overweight and obesity. Geneva: WHO; 2014.
- Devaux M, Sassi F. Social inequalities in obesity and overweight in 11 OECD countries. *Eur J Public Health.* 2013;23:464–9.
- FAO. Second International Conference on Nutrition. ICN2. 2014.
- World Health Organization. Data and statistics. The challenge of obesity. Geneva: WHO; 2016.
- Wilkinson R, Marmot M. Social determinants of health. The solid facts. 2nd ed. International Center for Health and Society. Geneva: WHO; 2003.
- Darmon N, Drewnowski A. Does social class predict diet quality? *Am J Clin Nutr.* 2008;87:1107–17.
- Rutter H. Where next for obesity? *Lancet.* 2011;378:746–7.
- Vandenbroek P, Goossens J, Marshall C. FORESIGHT. Tackling obesities: future choices-obesity. System atlas. GOS;. 2017.
- Burtland B, Jebb S, Kopelman P, et al. Foresight Tackling Obesities: Future Choices Project. Implications for research. Government Office for Sciences. UK;. 2007.
- EASO. Social sciences and humanities contribution to tackle the obesity epidemic challenges and potentials in obesity research towards Horizon 2020. European Association for the Study of Obesity; 2012.
- Plano Clark VL. The adoption and practice of mixed methods: US trends in federally funded health-related research. *Qualitative Inquiry.* 2010;16:428–40.
- Johnson RB, Onwuegbuzie AJ, Turner LA. Toward a definition of mixed methods research. *Journal of Mixed Methods Research.* 2007;2:112–33.
- Creswell JW, Klassen AC, Plano Clark VL, et al. Best practices for mixed methods research in the health sciences. Bethesda (Maryland): National Institutes of Health;. 2013:541–5.
- Gómez MCS. La dicotomía cualitativo-cuantitativo: posibilidades de integración y diseños mixtos. *Campo Abierto. Revista de Educación.* 2015;11–30.
- Rosemfield PL. The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. *Soc Sci Med.* 1992;35:1343–57.
- Cerdà JM, Rodríguez MP, García MH, et al. Técnicas cualitativas para la investigación en salud pública y gestión de servicios de salud: algo más que otro tipo de técnicas. *Gac Sanit.* 1999;13:312–9.
- Östlund U, Kidd L, Wengström Y, et al. Combining qualitative and quantitative research within mixed method research designs: a methodological review. *Int J Nurs Stud.* 2011;48:369–83.
- Creswell JW. Mapping the developing landscape of mixed methods research. *SAGE Handbook of mixed methods in social and behavioral research.* 2010;2:45–68.
- Holm L, Sandoe P, Nielsen MEJ, et al. Social sciences and humanities contribution to tackle the obesity epidemic challenge and potentials in obesity research towards Horizon 2020. EASO European Association for the Study of Obesity. 2012.
- Campbell F, Johnson M, Messina J, et al. Behavioural interventions for weight management in pregnancy: a systematic review of quantitative and qualitative data. *BMC Public Health.* 2011;11:491.
- Robertson C, Archibald D, Avenell A, et al. Systematic reviews of and integrated report on the quantitative, qualitative and economic evidence base for the management of obesity in men. *Health Tech Assess (Winchester, England).* 2014;18(35.).
- Everson-Hock ES, Johnson M, Jones R, et al. Community-based dietary and physical activity interventions in low socioeconomic groups in the UK: a mixed methods systematic review. *Prev Med.* 2013;56:265–72.
- Morse JM, Niehaus L. Principles and procedures of mixed methods design. 2009. In: Denzin NK, Lincoln YS, editors. *The Sage Handbook of qualitative research.* Sage: Thousand Oaks; 2011.
- Regoniel P. Quantitative methods: meaning and characteristics. University of Southern California;. 2015.
- Olson CM, Bove CF, Miller EO. Growing up poor: long-term implications for eating patterns and body weight. *Appetite.* 2007;49:198–207.
- Gardner B, Sheals K, Wardle J, et al. Putting habit into practice, and practice into habit: a process evaluation and exploration of the acceptability of a habit-based dietary behaviour change intervention. *Int J Behav Nutr Phys Act.* 2014;11:135.
- Huberty JL, Ehlers D, Coleman J, et al. Women bound to be active: differences in long-term physical activity between completers and noncompleters of a book club intervention. *J Phys Activ Health.* 2013;10:368–78.
- Duong DV, Lee AH, Binns CW. Determinants of breast-feeding within the first 6 months' post-partum in rural Vietnam. *J Paediatr Child Health.* 2005;41:338–43.
- Duram LA, Williams LL. Growing a student organic garden within the context of university sustainability initiatives. *International Journal of Sustainability in Higher Education.* 2015;16:3–15.
- Morrison LG, Hargood C, Lin SX, et al. Understanding usage of a hybrid website and smartphone App for weight management: a mixed-methods study. *J Med Internet Res.* 2014;16:43–62.
- Moy B, Renshaw I, Davids K. Variations in acculturation and Australian physical education teacher education students' receptiveness to an alternative pedagogical approach to games teaching. *Phys Educ Sport Pedagogy.* 2014;19:349–69.
- Whitford HM, Donnan PT, Symon AG, et al. Evaluating the reliability, validity, acceptability, and practicality of SMS text messaging as a tool to collect research data: results from the Feeding Your Baby project. *JAMIA.* 2012;19:744–9.
- Carruth BR, Skinner JD. Revisiting the picky eater phenomenon: neophobic behaviors of young children. *J Am Coll Nutr.* 2000;19:771–80.
- Stange KC, Crabtree BF, Miller WL. Publishing multimethod research. *Ann Fam Med.* 2006;4:292–4.
- Smith KE, Bamba C, Joyce KE, et al. Partners in health? A systematic review of the impact of organizational partnerships on public health outcomes in England between 1997 and 2008. *J Public Health.* 2009;31:210–21.
- O'Cathain A, Murphy E, Nicholl J. Multidisciplinary, interdisciplinary, or dysfunctional? Team working in mixed-methods research. *Qual Health Res.* 2008;18:1574–85.