Eating behaviors and health-related quality of life: A scoping review

O. Pano, M. Gamba Rincón, V. Bullón-Vela, I. Aguilera-Buenosvinos, Z. Roa Diaz, B. Minder, D. Kopp-Heim, J. Laine-Carmeli, M.A. Martínez González, J.A. Martinez, C. Sayón-Orea

PII: S0378-5122(22)00149-9

DOI: https://doi.org/10.1016/j.maturitas.2022.07.007

Reference: MAT 7665

To appear in:

Received date: 29 April 2022

Revised date: 6 July 2022

Accepted date: 13 July 2022

Please cite this article as: O. Pano, M.G. Rincón, V. Bullón-Vela, et al., Eating behaviors and health-related quality of life: A scoping review, (2022), https://doi.org/10.1016/j.maturitas.2022.07.007

Highlights

- Appropriate lifestyles improve the well-being of people with non-communicable diseases.
- Diet is a key aspect of lifestyle that results from social, cultural, and regional differences.
- Targeting eating behaviors in patients with chronic disease can significantly improve health-related quality of life.
- Research has overlooked particular eating behaviors, to the detriment of health-related quality of life.

Invited review

Eating Behaviors and Health-Related Quality of Life: A scoping review

Pano, O.[1], **Gamba Rincón, M.** [2,3], **Bullón-Vela, V.** [1], **Aguilera-Buenosvinos, I.**[1], **Roa Diaz, Z.** [2,3], **Minder, B.** [4], **Kopp-Heim, D.** [4], **Laine-Carmeli, J.** [2], **Martínez González, MA.** [1,5,6], **Martinez, JA**[7,8], **Sayón-Orea, C.** [1,5,9].

1. Department of Preventive Medicine and Public Health, Faculty of Medicine, University of Navarra, Pamplona Spain
2. Institute of Social and Preventive Medicine (ISPM), University of Bern, Bern, Switzerland.
3. Graduate School for Health Sciences, University of Bern, Switzerland
4. Public Health & Primary Care Library, University Library of Bern, University of Bern, Switzerland.
5. Centro de Investigación Biomédica en Red, Área de Fisiopatología de la Obesidad y la Nutrición. (CIBEROBN), Madrid, Spain.
6. Harvard T.H. Chan School of Public Health, Boston, MA, USA.
7. Department of Food Sciences and Physiology, University of Navarra, Pamplona, Spain.

8. Precision Nutrition and Cardiometabolic Health Program, IMDEA Food Institute, Madrid, Spain.
9. Navarra Institute for Health Research, IdiSNA, Pamplona, Spain. Navarra Public Health Institute, Navarra, Spain.

Corresponding Author: **Pano, O.** Department of Preventive Medicine and Public Health, University of Navarra, School of Medicine-Universidad de Navarra, Pamplona 31008, Spain. msayon@unav.es; +34 948 425-600

Abstract

Discrepancies between total life expectancy and healthy life expectancy are in part due to unhealthy lifestyles, in which diet plays an important role. Despite this knowledge, observational studies and randomized trials have yet to show consistent improvements in health and well-being, also known as health-related quality of life (HRQoL), given the variety of elements that conform to a healthy diet aside from its content. As such, we aimed to describe the evidence and common topics concerning the effects of modifiable eating behaviors and HRQoL in patients with non-communicable diseases (NCD). This scoping review of six electronic databases included 174 reports (69% were experimental studies, 10% longitudinal studies, and 21% cross-sectional studies). Using VOSviewer, a bibliometric tool with text mining functionalities, we identified relevant aspects of dietary assessments and interventions. Commonly observed topics in experimental studies were those related to diet quality (micro- and macronutrients, food items, and dietary patterns). In contrast, less was found regarding eating schedules, eating locations, culturally accepted food items, and the role of food insecurity in HRQoL. Disregarding these aspects of diets may be limiting the full potential of nutrition as a key element of health and well-being in order to ensure lengthy and fulfilling lives.

Keywords:

Eating Behaviors; Diet; Health Related Quality of Life; Lifestyles; Review

Introduction

While life-expectancy has increased across the globe, healthy life expectancy (HALE) has not [1]. Populations are aging rapidly, elderly individuals will represent 22% of the population in 2050, and yet most of their later years will be experienced in poor health [2]. More specifically, it is estimated that between 2015 and 2060 populations will be expected to live on average 18 years longer, of which only 5 will be experienced in good health [3, 4]. Lifestyle is a multifactorial determinant of longevity, and as such will play a determinant role in shifting these trends [5]. In addition to physical activity and smoking habits, eating behaviors are amongst the best-accepted determinants of health [6]. Despite this, defining a global, healthful dietary habits has proven to be a challenge due cultural, geography, and socioeconomic complexities of populations.

From the Mediterranean basin in the 1960's, the Mediterranean diet was characterized; a healthful dietary pattern that has gathered substantial support worldwide [7]. Adapting this eating pattern to other countries requires a number of modifications in order to preserve its innate dietary properties [7], and yet its cultural and socioeconomic appropriateness has not been questioned. '*What*' we eat, '*where*' and '*when*' we eat, along with '*who*', '*why*' and '*how*' we eat, henceforth the 5 W's and one H of eating behaviors, are secondary features of diets, which must also be adapted as they significantly influence health [8]. Evidence supporting the 5 W's and one H link the way eating schedules determine circadian rhythms [9], the importance of home and in-group cooking for healthier diets [7, 10], and explain the detrimental effects of food insecurity on health [11]. A better understanding of the 5W's and one H should be of general interest given the role of dietary factors in relation to cardiovascular diseases, cancer, diabetes, among other NCDs, and in term millions of yearly deaths worldwide [6].

Eating behaviors are a result of populational and individual interactions, which also influence our perceived health; also known as health-related quality of life (HRQoL). Further evidenced by the associations between dietary characteristics and HRQoL measures [12], meaning that self-perceived health is in part determined by daily eating behaviors [13, 14]. Understanding the role of the 5Ws and one H and their impact on HRQoL could help guide nutritional recommendations in accordance to health status, personal goals and values in order to improve HALE. Thus, this scoping review was devised to answer two main questions of 1)

what type of evidence exists on the associations between eating behaviors and HRQoL in populations with NCDs? and 2) what are the most common eating behaviors assessed and their effects on HRQoL measures?

Materials and Methods

A scoping review following the practices recommended by Peters, M. et. al. in 2015 [15] and the PRISMA checklist for scoping reviews was conducted [16]. The search strategy, inclusion and exclusion criteria, were aimed at giving context on the type of literature surrounding these reports, and frequently used methodologies in the form of a narrative review. Although the overall nature of the associations between eating behaviors with HRQoL was noted, an empirical analysis of these results was not the aim of our scoping review. The systematic search and initial screening of the evidence were conducted under the supervision of two information specialists.

Search strategy

A protocol was devised by the coauthors and prior to performing the search and, however it was not published. A total of six electronic databases were explored up to the final drafting of the manuscript: MEDLINE (Ovid), Embase.com, Cochrane Library, Web of Science, CINAHL (EBSCOhost), Global Health (Ovid); one search engine Google Scholar; and hand searching were carried out for this review. The search followed a modified 'PICO' strategy to identify: population, exposure, and outcome. The population portion of the search, aimed at including studies on community dwelling individuals with at least one of the following NCDs and cardiometabolic risk factors: glucose intolerance, overweight/obesity, hypertension, CVD (defined as stable angina, coronary heart disease, stroke, atrial fibrillation, or heart failure), diabetes, dyslipidemia, chronic kidney disease (CKD), obesity related cancers (esophagus, renal, pancreas, colorectal, prostate, breast, ovaries, endometrium), and NAFLD. For the exposure, a list of eating behaviors (Table 1) was created in conjunction with 3 nutritionists who included all relevant aspects of dietary behaviors best summarized by the 5Ws and one H: quality and nutrient assessment of diets intakes (*what*), eating schedules and time restricting eating patterns

(*when*), eating locations and environments (*where*), eating preferences based on cultural or social aspects, as well as personal dietary choices and restrictions such as food intolerances (*who* and *why*), and finally cooking and eating practices (*how*). *Who* and *why* were grouped given the overlapping of concepts based on the individual (*who*) and the reasons (*why*) behind their eating habits. Finally, the outcome was HRQoL measured through standard questionnaires. The information specialists were also in charge of including relevant synonyms for title, abstract and/or author keyword search and thesaurus terms (i.e. MeSH, Emtree) to the search when appropriate. The final search strategies are included as supplementary Tables 1-8.

Eligibility criteria

Inclusion criteria were: studies with longitudinal (both prospective and retrospective), cross-sectional, experimental studies; studies of free roaming individuals; reports must include associations or effects of at least one of the eating habits are displayed in Table 1 measured in quantitative manner or qualitatively form; finally HRQoL must be reported using the SF-36, the European quality five dimensions (EQ-5D) questionnaire, or the World Health Organization quality of life (WHOQOL) brief questionnaire. Exclusion criteria were: case studies, series of cases, systematic reviews or meta-analyses, letters to the editor, news, commentary papers, editorials, congress reports or posters, or protocol descriptions; samples from the general population, institutionalized patients or recovering from a surgical intervention; patients with major psychiatric disorders or cognitive disabilities; pregnant women or immediately after pregnancy; reports assessing or deriving utility measures from the HRQoL questionnaires; and articles in languages other than English, Spanish, German, Italian, or French.

A total of 5 investigators performed a blinded screening of the initial search results in a two-stage process. In the first stage, title and abstracts were screened to exclude studies that did not fulfil the inclusion and exclusion criteria. For the second stage, full texts were acquired for the remaining studies and screened in this same way. In the case of inconsistencies, a third independent investigator made the final decision of the inclusion or exclusion of the report.

Data extraction

The following data was extracted in a standardized spreadsheet: first author, year of publication, aims of the study, chronic condition amongst the study population, final sample size, percentage of female participants; age and standard deviation (SD) of the entire sample; HRQoL questionnaire used; the in-detail description of the eating behavior under analysis or targeted by the intervention including target of the intervention, object of the intervention, those who carried out the intervention and other descriptors; additional lifestyle interventions or exposure (physical activity, smoking status, sleeping disorders, cognitive or behavioral therapy, or a composite of these interventions) in the study; and the main findings relating eating behaviors with HRQoL. Validation of the data was performed by an independent reviewer. Raw data extraction is presented in Supplementary Material 1. Given the aims of the scoping review a quality assessment of the studies was not performed.

Data synthesis and analysis

Proportions were estimated for the type of study and population under study. The description of eating behavior exposures of all identified studies were analyzed using the text mining function of the VOSviewer tool version 1.6.18 developed by Nees Jan van Eck and Ludo Waltman of the University of Leiden [17]. The VOSviewer provides a word cloud analysis of common occurring terms and frequent associations, or links presented with a line. If an item presents multiple links these are recorded to conform a score which is visually represented by the size of an item. The 'network map' visualization arranges items in the form of clusters or communities of terms, each assigned a distinct color. Additionally, the VOSviewer allows for the inclusion of a thesaurus to solve for issues regarding the use of acronyms, synonyms, and alternative terminology for similar concepts. This feature was used to substitute the list of terms with their corresponding eating behaviors domain (what, when, where, who and why, and how) to identify common targets of the dietary interventions within the reports. Other parameters included in the VOSviewer tool were: for the network map, words were required a minimum of 5 occurrences to be analyzed, and only the top 75% of relevant terms were included, in contrast the eating behaviors network map included the top 80% of terms.

Similarly, these maps were performed on the studies conducted in populations with obesity/overweight, diabetes, CVD, CKD and cancer.

Results

Articles that were screened, identified, and selected are displayed in the flow diagram Figure 1. From the initial searches (final search on Feb. 4th 2022), N=7712 articles were retrieved. After deduplication 3267 reports were excluded, along with an additional 835 protocol reports, congress summaries or posters. The remaining 3610 articles were automatically screened in EndNote for the term protocol and excluded after manually verification; 26 protocols were identified. The remaining reports were manually screened in pairs using the inclusion and exclusion criteria; a total of 3370 were excluded leaving 214 for the full-text screening. Full texts exclusions (n=40) with reasons were: 16 studies were carried out in populations without NCDs, 14 for problems with the eating behavior intervention, 5 were excluded as they used non-standardized outcome measures, and an additional 4 were found to be study designs and one written in a foreign language (Portugues). The final selection included 174 articles (Figure 1).

We identified a total of 121 intervention studies (69%), 17 longitudinal studies (10%), and 36 cross-sectional studies (21%); Table 2 and Supplementary Material 1. Overall, these studies were conducted in patients with overweight or obesity (41.7%), followed by diabetes (25.1%), CVD (12.6%), CKD (8.0%), hypertension (6.3%), cancer (5.7%), and only one on patients with NAFLD (0.6%). Intervention studies focused on the effects of eating behaviors alone (49.7%), however, 14.3% additionally studied the effects of physical activity, or a comprehensive lifestyle intervention/assessment, 18.9%. Behavioral therapy was seldom conducted alone, only 2.3%, but rather it complemented a complete lifestyle intervention (11.4%). Only 15 studies (8.6%) were conducted in purely female populations, and only 5 (2.9%) in purely male populations. The populations under study ranged from studies on adolescents (13 years (SD: 1.32)) [18] to elderly populations (80.8 years (SD: 8.5)) [19].

Results from the full text analysis of eating behavior assessments on VOSviewer, Figure 2, revealed a network map with a total of 6 clusters in a triangular disposition. The red cluster included food related terms; '*protein*', '*fruit*' '*fat*' and '*supplement*' stand out. The blue and yellow clusters relate to the form and frequency of an intervention: '*session*' '*month*' '*activity*' and '*visit*'.

Finally, the green cluster encompassed the dietary assessment measures; '*item*' '*score*' '*factor*' '*scale*'. The green cluster additionally included terms such as binge eating disorder, or '*bed*', and terms related to the assessment of cognitive and behavioral domains relating to eating behaviors. When substituting the terms list for the corresponding 5Ws and one H relating (Figure 3) and using the density visualization of the map, we find that interventions and study associations mostly relate to the diet content and quality (what). This term also corresponded to the location of food items observed in Figure 2. Less prominent where studies analyzing the timing of eating behaviors (when), eating environments (where), and the form of feeding (how), such as binge eating disorders (BED). The eating behaviors related to the individual's food culture, and their personal selection of eating habits (who and why) were less relevant in the analyzed articles; not appreciated in the figure.

Finally, network maps of the sub-populations overweight/obesity, diabetes, CVD, CKD, and cancer revealed terms relating to dietary patterns and eating schedules; Figures 4-8. These figures highlight a great focus on dietary quality and eating behaviors alterations, and yet, for some populations such as those with CKD and cancer the diversity of assessment and intervention descriptions limited the amount of identified terms that related to eating behaviors. Supplementary Figures 1 and 2, reflect text analysis of experimental and observational studies respectively. For experimental studies, a similar diagram emerged with clusters such as those related to dietary nutrients and food items, as well as dietary assessments and barriers to dietary interventions. In the case of observational studies, a greater description was provided on the origin of data, such as food frequency questionnaires, and scoring systems, but also dietary quality elements.

Discussion and Narrative review

In this scoping review of eating behaviors and HRQoL of samples with reported NCDs, dietary quality was a common eating behavior goal for observational and experimental studies. Focusing on the populations with cancer and CVD, the Mediterranean diet and fat sources were common targets in these samples. Observational studies analyzed a variety of dietary components in relation to quality: overall healthy diets [20], the Mediterranean diet [21], fruit and vegetable intakes [22], or salt intake [23]. Experimental studies, on the other hand, aimed to

improve health and HRQoL through a variety of dietary patterns, mainly the dietary approaches to stop hypertension (DASH) [24], ketogenic diets [25, 26], an adapted Okinawan diet for a Nordic population [27] and again, the Mediterranean diet [28]. Additionally, interventions frequently focused on the use of dietary supplements such as vitamin D, L-carnosine, L-arginine, sodium propionate, or probiotics [29]. In contrast, the remaining 4Ws and one H were not as commonly analyzed. Studies relating to eating schedules (*when*) included analysis of breakfast, lunch, dinner, and even snacking behaviors [27, 30, 31]. These concepts were clustered in conjunction with forms of eating (*how*) such as binge eating patterns and BED, hunger management, and eating restrictions [32-35]. Cooking workshops, [36-38] or recipe books [39, 40] were also common strategies to improve how meals were prepared. In contrast, eating location (*where*) was less relevant among the included studies. Only three reports included recommendations to participants when eating out or on holidays [41-43]. Finally, culturally appropriate diets [44] or delivering interventions in places of worship [45] to improve the impact of dietary practices (*who* and *why*) were scarce among the collected studies.

Additionally, text analysis was conducted on specific populations with NCDs. In Figures 4-8, specific aims of the interventions and assessments were identified. For samples of patients with obesity or overweight, the terms "*supplement*", "*lunch*", and "*dinner*" were central. Therefore, the identified studies aimed there assessments to timing of meals, but also at identifying and modifying detrimental eating practices as evidenced by the terms "*response*" and "*disinhibition*" [33, 46, 47]. Studies on samples of populations with diabetes on the other hand were less prominent, however quality of diets (relating to the terms "*fruit*", "*fat*", "*carbohydrate*", and "*meal diet*"), and detrimental feeding behaviors (relating to the terms "*BED*" and "*snack*") were prevalent topics within the analyzed studies. Interestingly, these terms align with common priority dietary goals for these patients in whom low carbohydrate diets and healthy fats are recommended in order to avoid glycemic spikes and other detrimental outcomes [48, 49]. In the case of both CKD and CVD, less studies and therefore less information was obtained on the dietary assessments however, in studies of patients with CVD the terms "*butter*" "*cheese*" and "*vegetables*" were identified in the text analysis [50, 51]. These terms fall in line with key nutritional interventions to avoid coronary infarctions by reducing the intake of saturated fats, in favor of monounsaturated or polyunsaturated fats. Contrastingly, samples of participants with CKD centered on nutrient adequacy given the heightened risk of malnutrition

in these patients; evidenced by the terms "*macronutrient*", "*energy intake*", and indirectly "*body weight*" [52]. Finally, studies on samples with cancer described interventions and assessments relating to the side-effects of patient "*treatment*", and included dietary concepts such as "*fat*", "*meddiet*", and "*protein*", no other eating behavior was identified in these patients, which could have been due to the low amount of reports on these samples [53].

Among the studies that assessed the role of diet quality on HRQoL, mixed results were found. The Mediterranean diet was a common assessment across study designs (one cross sectional, two longitudinal, and 8 intervention studies) and particularly for populations with overweight/obesity, diabetes and cancer [21]. Experimental studies, reported inconsistent improvements of HRQoL in samples with CVD and obesity or overweight [54, 55]. Interestingly, the studies that reported null associations with HRQoL were promoting non-traditional food items of this dietary pattern [7]; mainly pasta and pork consumption [39, 51]. Of note regarding quality of diets, salt and sodium intake were common assessments across studies. Given the link to hypertension and CVD, compliance to sodium restrictions was a common assessment in multiple studies [22, 56, 57]. Particularly, the intervention by Kim JK, et al. in 2020 focusing on sodium restriction, dietary risk factors for CVD, and physical activity, which significantly reduced to salt intake and increased HRQoL [58].

Form of eating and dietary schedules were items with multiple links between terms, particularly with diet quality concepts, and specifically in samples of overweight or obesity individuals. Cross sectional studies found inverse associations between BED scales and HRQoL [35, 59, 60] and experimental studies confirmed the difficulties of improving HRQoL in the absence of concomitant BED improvements [32, 61-63]. From these studies, three reports from the Look AHEAD trial stand out as they analyze the role of psychiatric disorders in relation to behaviors and HRQoL. This trial of subjects with diabetes at risk of depression, the smallest of which included over 3000 participants, found that participants with higher baseline HRQoL had less weight variability over a period of eight years despite the presence of depressive symptoms [58, 62, 64]. However, after an intensive lifestyle intervention that promoted self-monitoring and adherence to dietary restrictions in addition to behavioral therapy, researchers reported no improvements in SF-36 scores [58, 64]. Similar results were found in studies of samples with diabetes despite the increase in adherence to the Mediterranean diet [65]. Considering our findings, it could be hypothesized that the lack of effectiveness might be due to the lack of

promoting healthy eating schedules in patients with diabetes given their role in the regulation of circadian rhythms and significant improvements in depressive symptoms [9].

Cultural acceptability of diets in relation to food items, cooking styles, and individual preferences were less studied amongst the selected articles, despite some noteworthy reports. D'Eramo Melkus et al. in 2010 conducted an intervention promoting 'soul foods', family dinners, and identified cultural barriers for healthy diets for female African-Americans [44]. In this study, participants under culturally relatable interventions saw sustained improvements in various domains of HRQoL [44]. In this same line, Samuel-Hodge, et al. in 2009 aimed to improve self-management of patients with diabetes through a church-based, lifestyle intervention program compared to mail-in recommendations in an African-American sample [45]. After a year of intervention, the intervention and control groups had similar improvements in diet quality and physical activity levels. Nonetheless, HRQoL scores were higher in the church-based intervention group [45]. The study by Gholami, A., et al. in 2017 in patients with diabetes from a rural context in Iran stands out mainly due to the absence of similar studies on food security as a determinant of well-being [66]. In this cross-sectional analysis, physical and mental components of HRQoL were inversely associated with level of food security. Based on the burden of food insecurity in these underserved populations around the world and its relation to HRQoL, we suggest that more research is conducted, especially as food insecurity is predicted to increase with climate change [67]. Taken together, the role of the individual, particularly cultural-relatedness towards eating habits [44] and spirituality at improving perceived health [45], as well as socioeconomic determinants in relation to HRQoL are areas of future research in need of expansion.

In conjunction, the correct assessment and improvement of all eating behaviors allows for diets to become culturally, socially and regionally diverse, in addition to significantly contributing to the health of all age-groups and ethnicities. Public health implications require further research as to the potential improvements in health when integral and personalized dietary recommendations are implemented. However, we speculate that targeting individual eating behaviors might improve the adherence to dietary changes and lifestyles in general; a commonly identified limitation to lifestyle interventions. Future research should aim to center on each of the 5W's and one H, in order to determine key factors that determine dietary adherence and in term result in health improvements. The implications of this field of research

are divided into two tiers: for individuals presenting chronic diseases, the 5Ws and one H allow for dietary recommendations to remain enriching while complying to disease specific limitations; and in terms of populations, personalized eating behaviors could facilitate the compliance to healthier diets, improve biological parameters, and potentially reduce the gap between years lived and HALE.

The identification of articles and their presentation in this review serve as an overview of commonly used methods and practices in dietary interventions and assessment methods, revealing a critical absence of eating behaviors in relation to HRQoL, aside from content and quality. Admittedly, most of these interventions were conducted by trained dietitians or trained professionals, however, the use of sparse group sessions proves to be a difficult scenario to address the eating habits and concerns of participants. Key limitations to this review arise from the lack of a formal quality assessment of the included studies (ie. bias assessments, adjustment for confounders, comparisons to control groups). This lack of quality standards was noted by the screening team, along with the absence of validated dietary assessments, and in occasions potential conflicts of interest in studies funded by food industry giants, which may lead to biased results. Researchers are therefore encouraged to use validated dietary assessment measures, use of adequate controls, as well as the inclusion of the 5Ws and one H of eating behaviors in future research. Additionally, the text analysis feature of the VOSviewer relies greatly on the quality of the intervention/assessment description. Given that journals often impose limits to the extent of manuscripts, researchers might limit their descriptions of interventions and therefore their contributions to the pool of terms would remain relatively low. Finally, the results do not reflect the effectiveness of dietary interventions, meaning that despite the presence of reoccurring terms, these lack association measures that relate them to effective nutritional strategies. Some strengths of this review include the use of the VOSviewer tool, minimizing the biased assessment of texts. Another strength of the study, is that only studies that went through the peer-review process were selected, ensuring to some extent the detailed description of methods and techniques.

Conclusions

From the 174 studies selected to assess eating behaviors in relation to HRQoL of samples with a variety of NCDs, we observed a variety of results regarding the association between eating behavior and HRQoL. Based on raw text analysis, we observed a high frequency of assessments related to the quality of diets, ranging from dietary patterns such as the Mediterranean diet to micronutrients such as salt intake. Other aspects of eating behaviors were less explored such as eating schedules, site of diet intakes, and perjurious habits such as binge eating disorders or snacking. Considering social, cultural and individual aspects of diets and their positive influence on well-being and HRQoL, we would encourage their inclusion into standard dietary interventions and assessments, with the potential benefits of healthier dietary practices, improvements in physical and mental health, and of healthier lives as a whole.

Contributors

O. Pano conceived and designed the analysis, collected the data, performed the analysis, wrote the initial draft, and reviewed the manuscript.

M. Gamba Rincón collected the data, performed the analysis, and reviewed the manuscript.

V. Bullón-Vela collected the data, performed the analysis, and reviewed the manuscript.

I. Aguilera-Buenosvinos collected the data, performed the analysis, and reviewed the manuscript.

Z. Roa Diaz collected the data, performed the analysis, and reviewed the manuscript.

B. Minder conceived and designed the analysis, collected the data, and reviewed the manuscript.

D. Kopp-Heim conceived and designed the analysis, collected the data, and reviewed the manuscript.

J. Laine-Carmeli conceived and designed the analysis, and reviewed the manuscript.

M. A. Martínez González reviewed the manuscript.

J. A. Martinez reviewed the manuscript.

C. Sayón-Orea conceived and designed the analysis, collected the data, performed the analysis, and reviewed the manuscript.

Funding

This work was supported by the University of Navarra, Pamplona Spain. Octavio Pano, received funding from "Fundación Caja de Navarra" and "Fundación La Caixa" as a part of a doctoral exchange program supported by the University of Navarra, Pamplona Spain.

The funding source was not involved in the inception, objectives, search strategy development, reporting, nor the decision to publish this work.

Provenance and peer review

This article was commissioned and was externally peer reviewed.

Declaration of competing interest

The authors declare that they have no competing interest.

Tables and Figures

Table 1. Complete list of Eating behaviors concepts categorized as 5Ws and one H.

Eating Behavior Concept	Terms list
"What"	Food diversity, nutrient-dense foods, malnutrition, Balanced nutrition, vegan diet, vegetarian, sustainable diets, plant based diet*, meal patterns, nutrient-poor diets, and Junk Food.
"When"	Meal Frequency, mealtime, food timing, regular meals, largest meal, fasting duration, time restricted eating, time restricted feeding, intermittent fasting, caloric restriction, intermittent fasting, daily restriction, Meal skipping, Breakfast skippers, breakfast skipping, Snack*, snacking habits, snacking behavior, snacking frequency, snacking pattern, Late night eating, late eat*, night eating, Chrononutrition, Chrono-nutrition, temporal eating pattern*, temporal eating behavior* Descriptors: irregular, regular,
"Where"	Eating environment, feeding environments, out-of-home *Eating, consumption*, , takeaway, take away, restaurant food, eating out, fast-food purchases, fast-food restaurants, fast-food consumption, commercial meals, home cook*, Home eating, homemade
"Who"	Eating program, meal program, food program, hunger relief, food insufficien*, Meal preferences, Meal cost, Consumer attitudes, acculturation, dietary acculturation, dietary culture*, diet culture, Traditional meals, Diet intolerance*, food intolerance, metabolic defect*
"Why"	Nourishment, mood food, starvation
"How"	Binge eating, binge behavior, binge status, prudent eating, prudent diet*, overeating, under eating, cooking patterns, Shared meals, family meal*, actual living conditions
List of terms that correspond to the six eating behavior domains. Terms were included in the systematic search by BM and DK.	

Table 2. Description of included articles according to study design and population.

Population under study	Included Studies (n=174)
Experimental studies (n= 121, 69%)	
Overweight/obesity	45.5%
Hypertension	5.8%
CVD# (including stable angina, coronary heart disease, stroke, atrial fibrillation, or heart failure)	12.4%
Diabetes	22.3%
Chronic kidney disease	6.6%
Cancer (esophagus, renal, pancreas, colorectal, prostate, breast, ovaries, endometrium)	6.6%
NAFLD*	0.8%
Longitudinal studies (n= 17, 10%)	
Overweight/obesity	35.3%
CVD# (including stable angina, coronary heart disease, stroke, atrial fibrillation, or heart failure)	29.4%
Diabetes	17.6%
Chronic kidney disease	6.9%
Cancer (esophagus, renal, pancreas, colorectal, prostate, breast, ovaries, endometrium)	11.8%
Cross-sectional studies (n=36, 21%)	
Overweight/obesity	30.6%
Hypertension	11.1%
CVD# (including stable angina, coronary heart disease, stroke, atrial fibrillation, or heart failure)	5.6%
Diabetes	38.9%
Chronic kidney disease	13.9%

#: Cardiovascular disease, *: Non-alcoholic fatty liver disease.

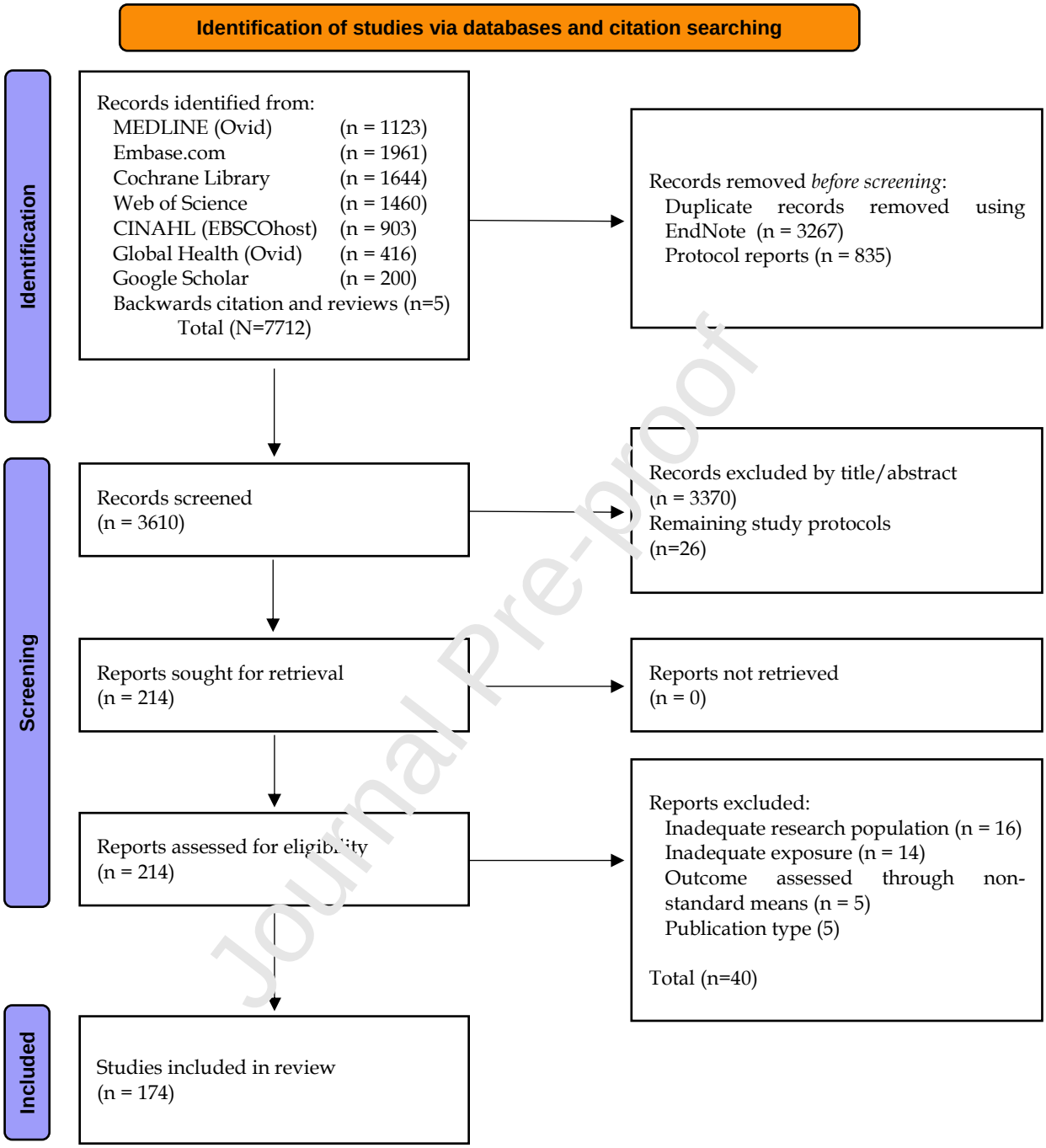

Figure 1. Flow diagram of article screening and exclusion. Based on the 2020 PRISMA guidelines.

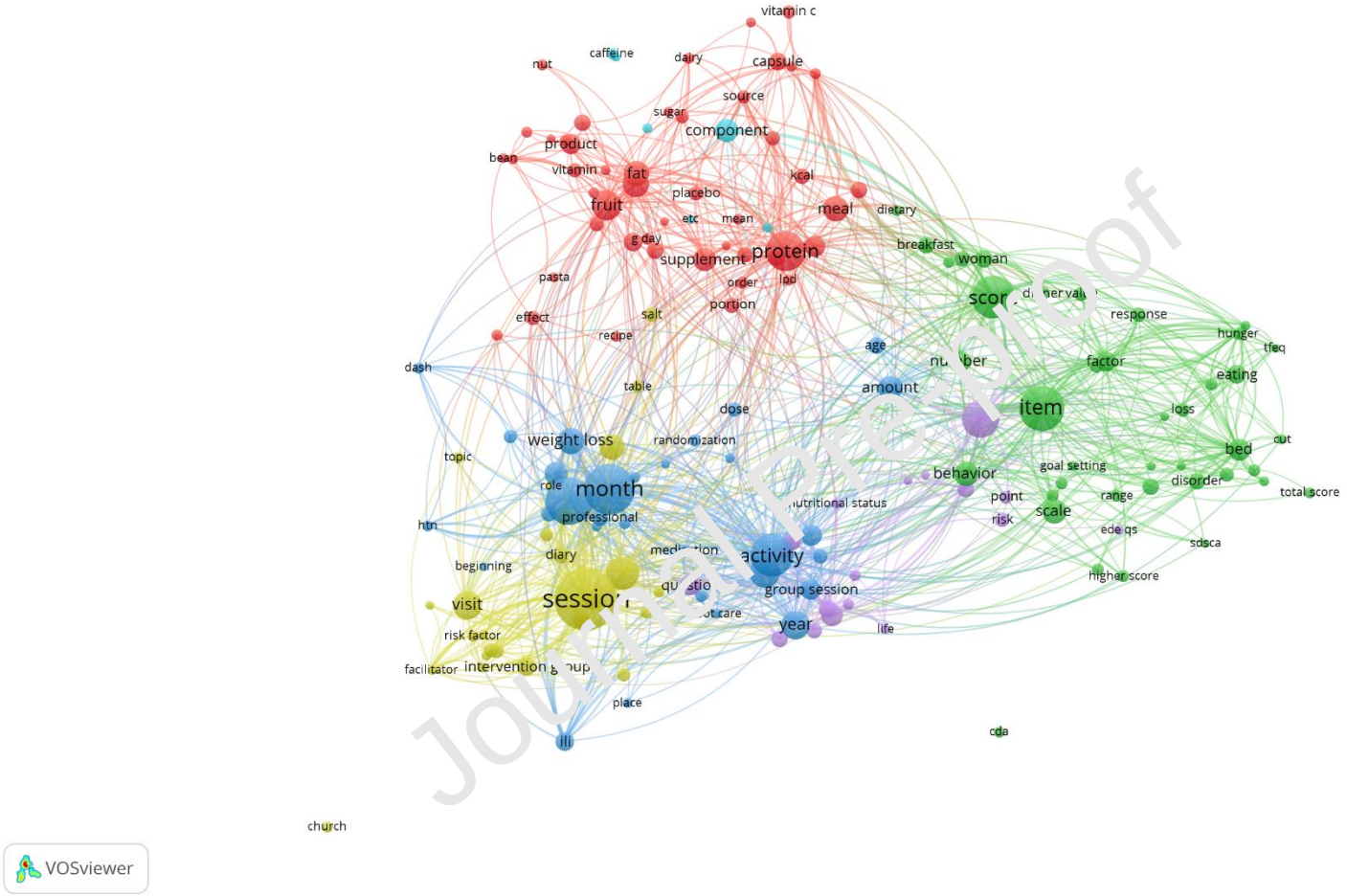

Figure 2A. Full text analysis of dietary assessment methods and interventions of the selected 174 studies. Network map of results identifying commonly occurring concepts, their associations, and clustering. Created with the VOSviewer tool [17].

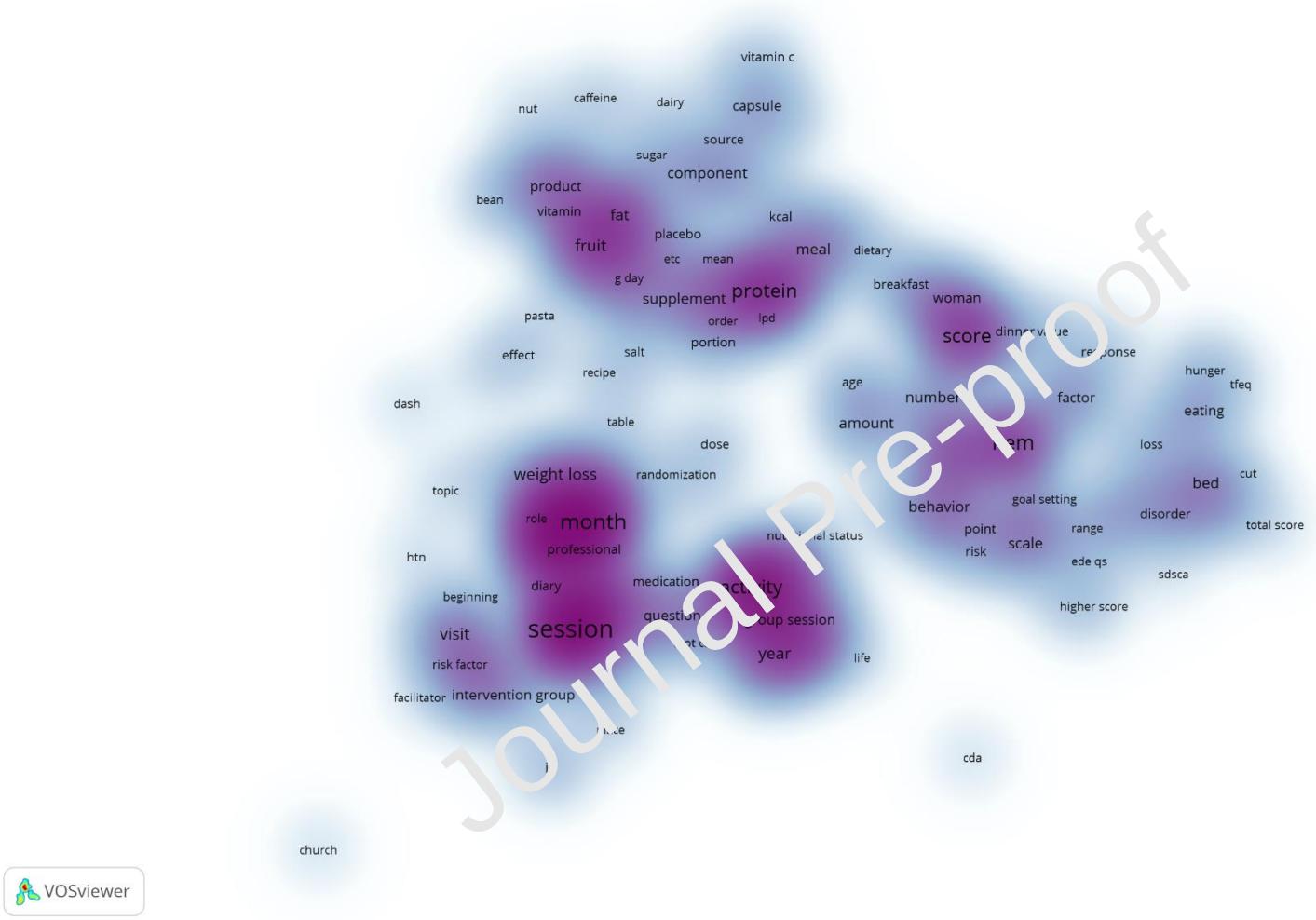

Figure 2B. Full text analysis of dietary assessment methods and interventions of the selected 174 studies. Panel B: Density Map of the text analysis results identifying regions of most frequently occurring topics. Created with the VOSviewer tool [17].

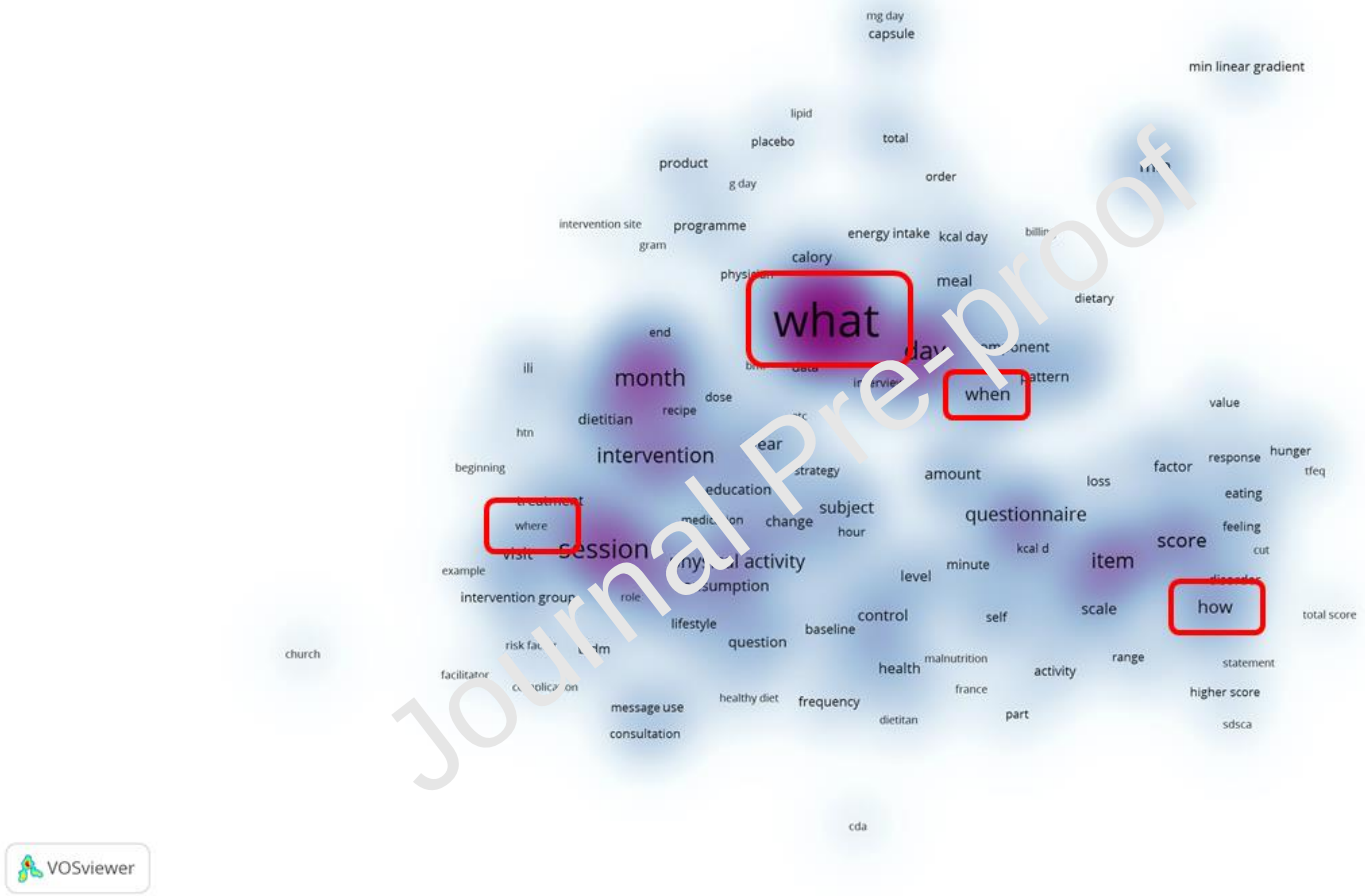

Figure 3. Density map identifying the 5Ws and one H of eating interventions in the identified studies. Highly relevant and reoccurring topics are highlighted. Created with VOSviewer version 1.6.18 [17].

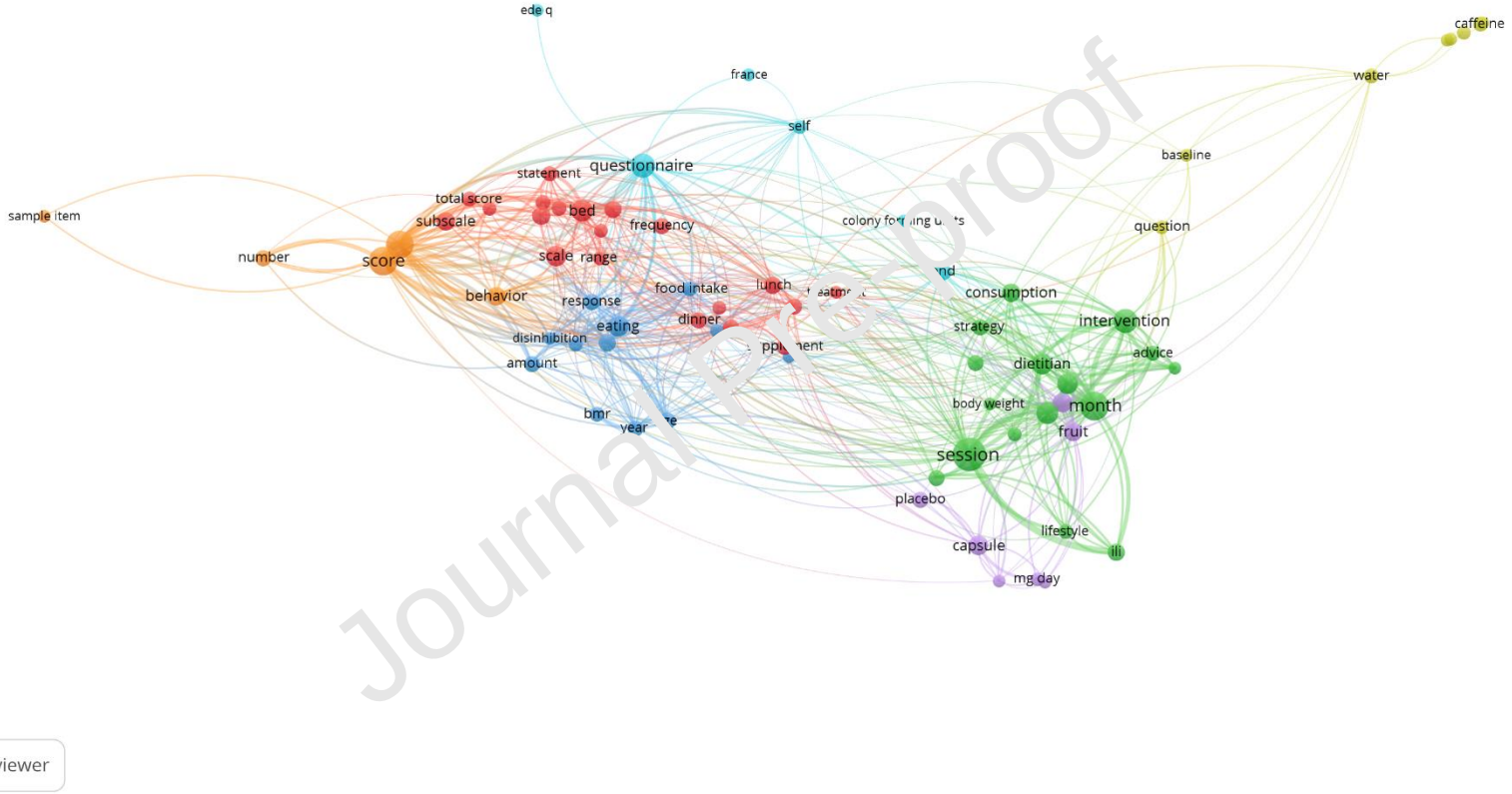

Figure 4. Full text analysis of dietary assessment methods and interventions for studies on patients with overweight or obesity. Created with the VOSviewer tool [17].

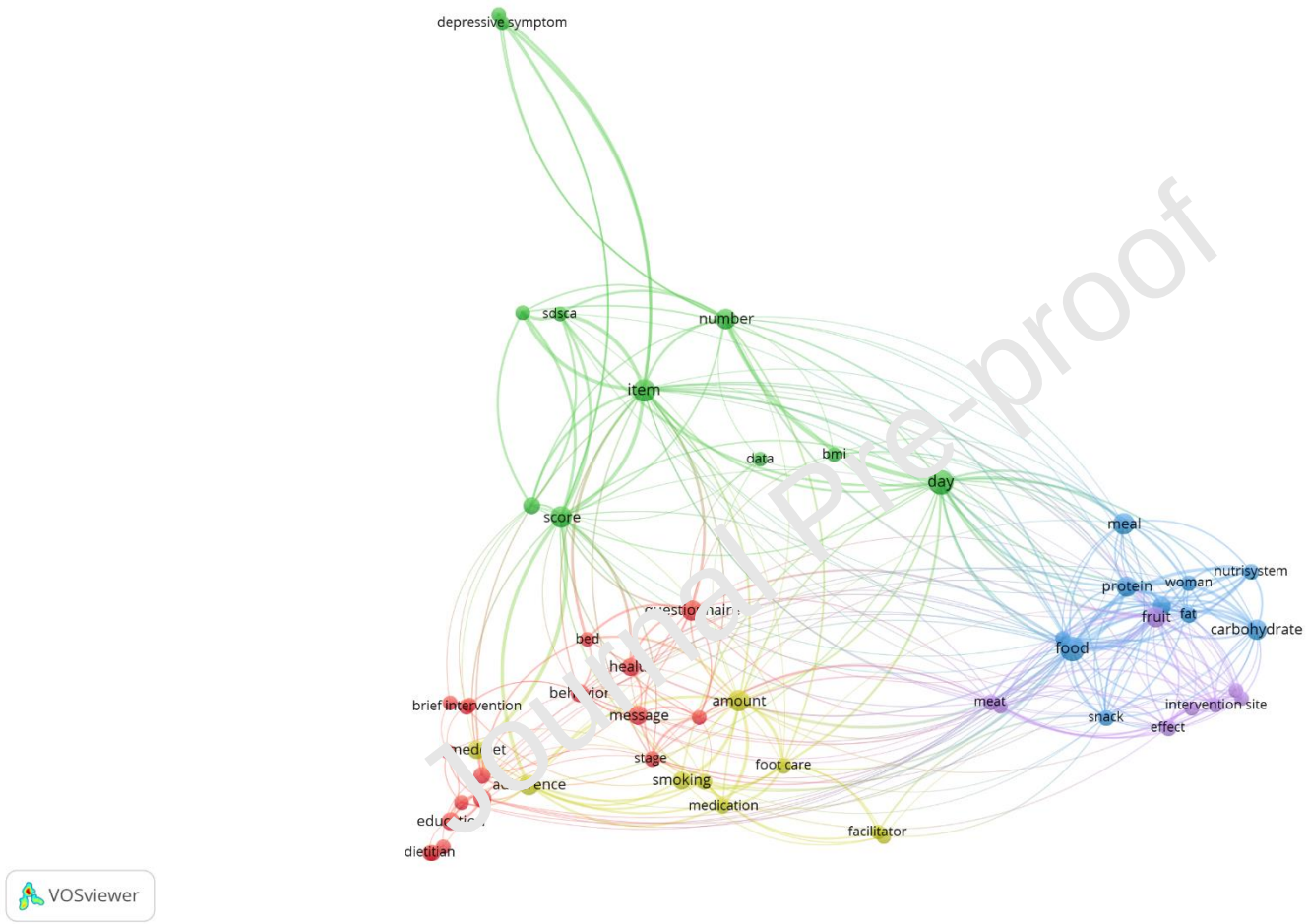

Figure 5. Full text analysis of dietary assessment methods and interventions for studies on patients with diabetes. Created with the VOSviewer tool [17].

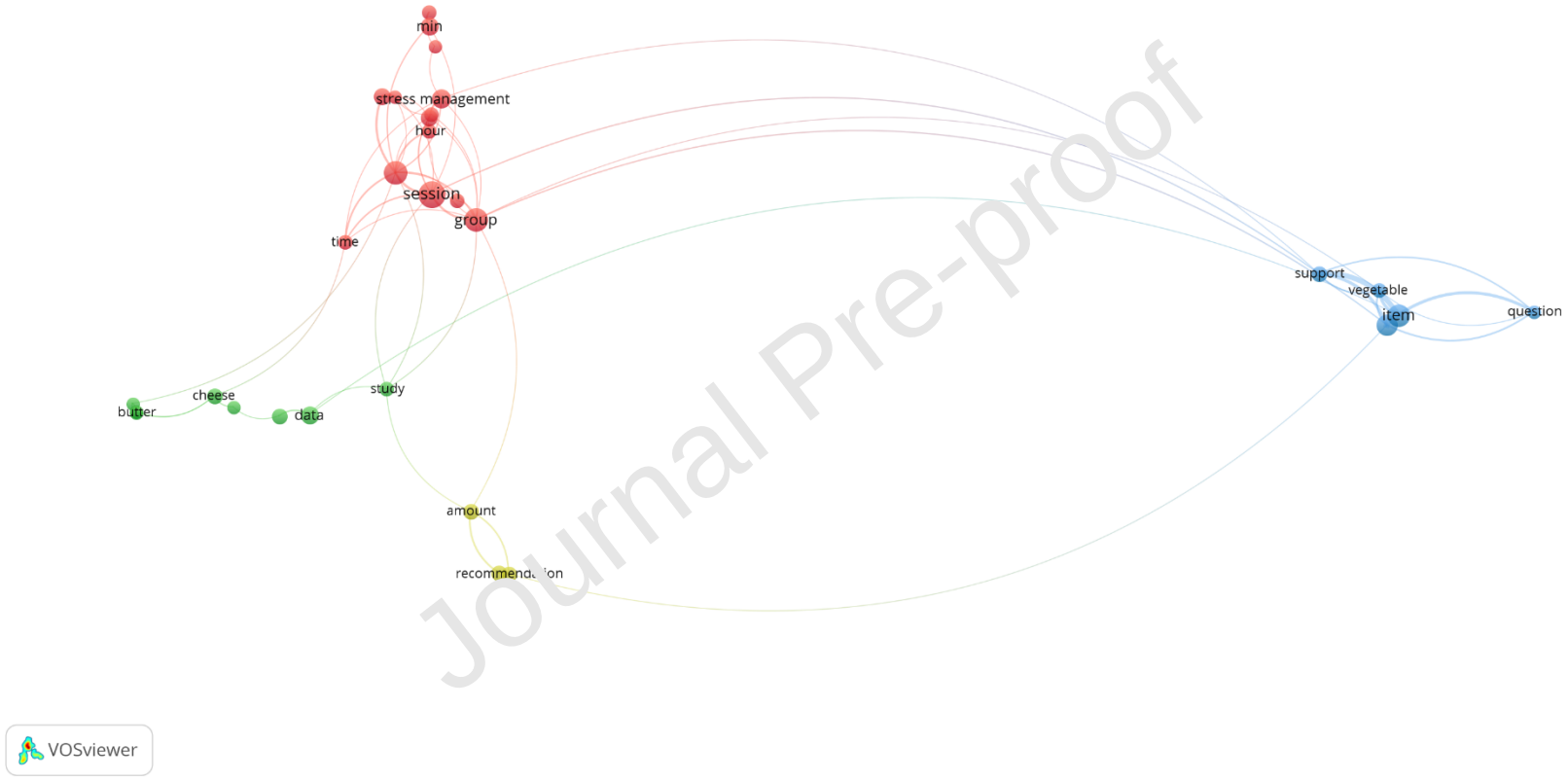

Figure 6. Full text analysis of dietary assessment methods and interventions for studies on patients with CVD. Created with the VOSviewer tool [17].

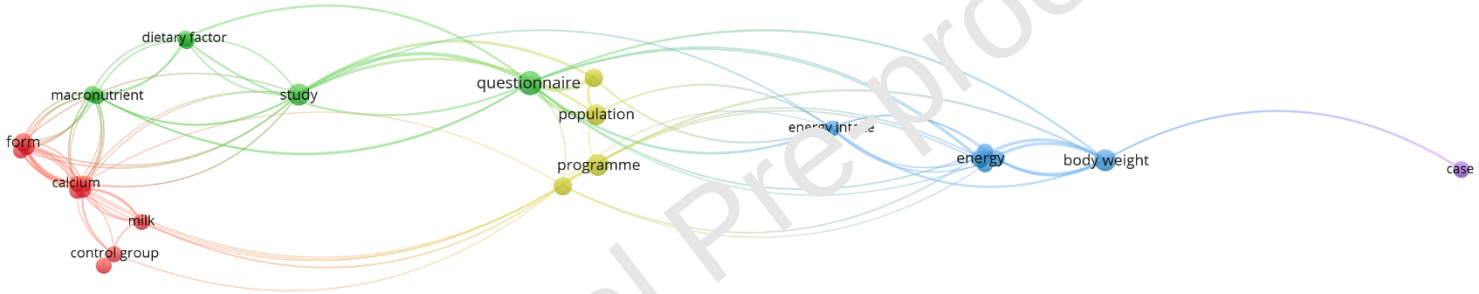

Figure 7. Full text analysis of dietary assessment methods and interventions for studies on patients with CKD. Created with the VOSviewer tool [17].

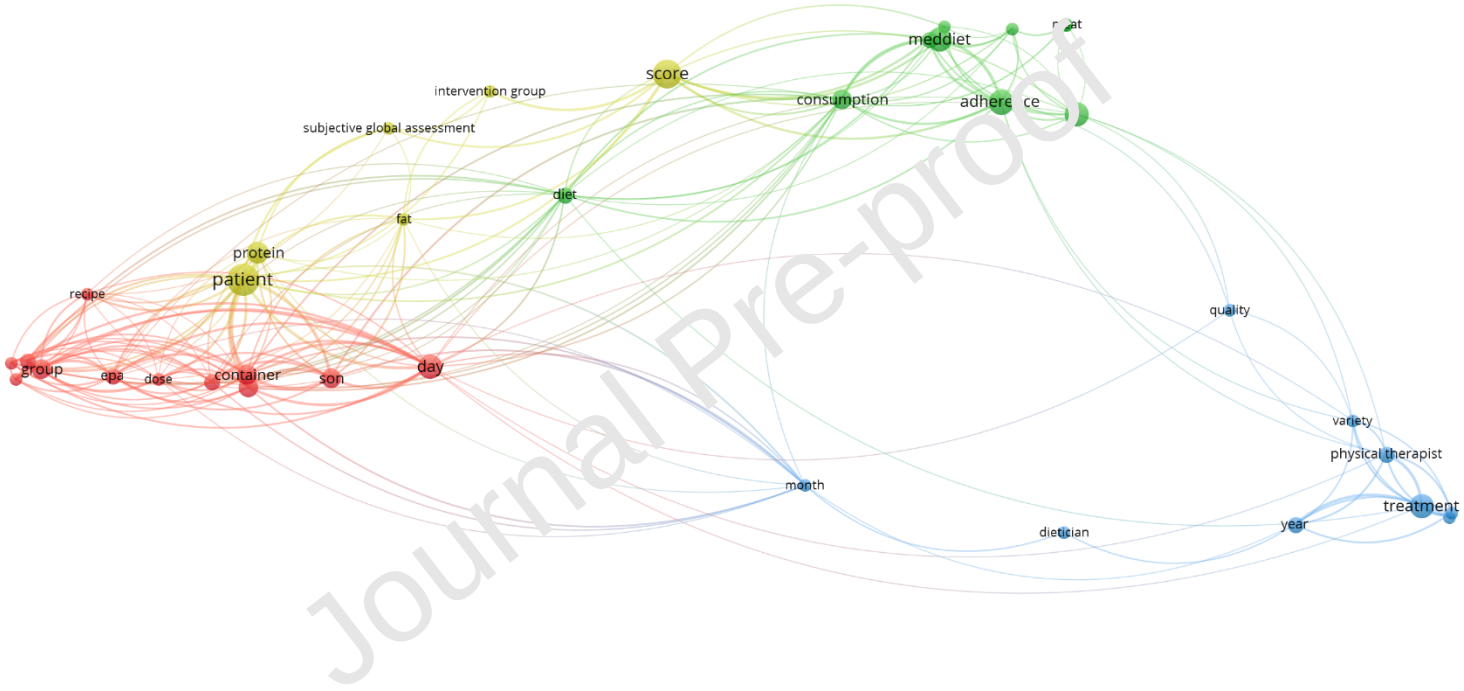

Figure 8. Full text analysis of dietary assessment methods and interventions for studies on patients with cancer. Created with the VOSviewer tool [17].

References

[1] O. World Health, WHO methods and data sources

for life tables 1990-2019, 2020. https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-life-expectancy-and-healthy-life-expectancy#:~:text=Globally%2C%20life%20expectancy%20has%20increased,reduced%20years%20lived%20with%20disability.
[2] H. Wang, et al., Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019, The Lancet 396(10258) (2020) 1160-1203.
[3] H.H. Kyu, et al., Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017, Lancet 392(10159) (2018) 1859-1922.
[4] H.D. Wang, et al., Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015, Lancet 388(10053) (2016) 1459-1544.
[5] G. Dahlgren, M. Whitehead, The Dahlgren-Whitehead model of health determinants: 30 years on and still chasing rainbows, Public Health 199 (2021) 20-24.
[6] T. Vos, et al., Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019, The Lancet 396(10258) (2020) 1204-1222.
[7] M.A. Martinez-Gonzalez, et al., Transferability of the Mediterranean Diet to Non-Mediterranean Countries. What Is and What Is Not the Mediterranean Diet, Nutrients 9(11) (2017).
[8] K. Wickramasinghe, et al., From lifespan to healthspan: the role of nutrition in healthy ageing, J Nutr Sci 9 (2020) e33.
[9] T. Sato, P. Sassone-Corsi, Nutrition, metabolism, and epigenetics: pathways of circadian reprogramming, EMBO reports (2022).
[10] M.S. Hershey, et al., The Mediterranean lifestyle (MEDLIFE) index and metabolic syndrome in a non-Mediterranean working population, Clin Nutr 40(5) (2021) 2494-2503.
[11] J.T. Cook, et al., Are Food Insecurity's Health Impacts Underestimated in the U.S. Population? Marginal Food Security Also Predicts Adverse Health Outcomes in Young U.S. Children and Mothers, Advances in Nutrition 4(1) (2013) 51-61.
[12] O. Pano, et al., Nutritional Determinants of Quality of Life in a Mediterranean Cohort: The SUN Study, Int J Environ Res Public Health 17(11) (2020) 3897-3897.
[13] M. Karimi, J. Brazier, Health, Health-Related Quality of Life, and Quality of Life: What is the Difference?, Pharmacoeconomics 34(7) (2016) 645-9.
[14] B. de Cuevillas, et al., Definition of nutritionally qualitative categorizing (proto)nutritypes and a pilot quantitative nutrimeter for mirroring nutritional well-being based on a quality of life health related questionnaire, Nutr Hosp 36(4) (2019) 862-874.
[15] M.D. Peters, et al., Guidance for conducting systematic scoping reviews, Int J Evid Based Healthc 13(3) (2015) 141-6.

[16] M.J. Page, et al., The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, BMJ (2021) n71.
[17] N.J. Van Eck, L. Waltman, Software survey: VOSviewer, a computer program for bibliometric mapping, Scientometrics 84(2) (2010) 523-538.
[18] H. Dreber, et al., Health-Related Quality of Life 5 Years After Roux-en-Y Gastric Bypass in Young (18-25 Years) Versus Older (>/= 26 Years) Adults: a Scandinavian Obesity Surgery Registry Study, Obes Surg 29(2) (2019) 434-443.
[19] P. Matia Martin, et al., Effectiveness of an oral diabetes-specific supplement on nutritional status, metabolic control, quality or life, and functional status in elderly patients. A multicentre study, Clin Nutr 38(3) (2019) 1253-1261.
[20] J. Li, et al., Correlations between health-promoting lifestyle and health-related quality of life among elderly people with hypertension in Hengyang, Hunan, China, Medicine (Baltimore) 97(25) (2018) e10937.
[21] A. Cordwell, et al., Adherence to a Mediterranean diet and health-related quality of life: a cross-sectional analysis of overweight and obese middle-aged and older adults with and without type 2 diabetes mellitus, British Journal of Nutrition.
[22] W.F. Khaw, et al., Quality of life in hypertensive patients: The impact of socio-demographic and lifestyle factors, International Medical Journal 24(1) (2017) 56-60.
[23] S. Ghimire, et al., Factors Associated With Health-Related Quality of Life among Hypertensive Patients in Kathmandu, Nepal, Front. cardiovasc. med. 4 (2017) 69.
[24] S.L. Fitzpatrick, et al., Predictors of Long-Term Adherence to Multiple Health Behavior Recommendations for Weight Management, Health Education & Behavior 45(6) (2018) 997-1007.
[25] E. Moriconi, et al., Very-low-calorie ketogenic diet as a safe and valuable tool for long-term glycemic management in patients with obesity and type 2 diabetes, Nutrients 13(3) (2021) 1-15.
[26] W.S. Yancy, Jr., et al., Effects of two weight-loss diets on health-related quality of life, Qual Life Res 18(3) (2009) 281-9.
[27] B. Ohlsson, et al., High Fiber Fat and Protein Contents Lead to Increased Satiety Reduced Sweet Cravings and Decreased Gastrointestinal Symptoms Independently of Anthropometric Hormonal and Metabolic Factors, Journal of Diabetes & Metabolism 8(3) (2017).
[28] A. Lemanska, et al., Patient activation and patient-reported outcomes of men from a community pharmacy lifestyle intervention after prostate cancer treatment, Supportive Care in Cancer 30(1) (2022) 347-358.
[29] A.F.G. Cicero, et al., Impact of a short-term synbiotic supplementation on metabolic syndrome and systemic inflammation in elderly patients: a randomized placebo-controlled clinical trial, Eur J Nutr 60(2) (2021) 655-663.
[30] J.J. Lopez-Gomez, et al., Influence of a meal-replacement diet on quality of life in women with obesity and knee osteoarthritis before orthopedic surgery, Nutr Hosp 35(1) (2018) 71-77.
[31] B. Afsar, et al., The relationship between breakfast, lunch and dinner eating pattern and hemodialysis sessions, quality of life, depression and appetite in hemodialysis patients, Int Urol Nephrol 44(5) (2012) 1507-14.
[32] K.K. Danielsen, et al., Beyond weight reduction: improvements in quality of life after an intensive lifestyle intervention in subjects with severe obesity, Ann Med 46(5) (2014) 273-82.
[33] G. Marchesini, et al., Health-related quality of life in obesity: the role of eating behaviour, Diabetes Nutr Metab 13(3) (2000) 156-64.
[34] F. Cerrelli, et al., Eating behavior affects quality of life in type 2 diabetes mellitus, Eat Weight Disord 10(4) (2005) 251-7.

[35] L. Busetto, et al., Determinants of health-related quality of life in morbid obese candidates to gastric banding, Eat Weight Disord 17(2) (2012) e93-100.
[36] C.R. Martin, et al., Effycacy of an Educational Intervention Group on Changes in Lifestyles in Hypertensive Patients in Primary Care: A Randomized Clinical Trial, Revista Espanola De Salud Publica 83(3) (2009) 441-452.
[37] U. Agarwal, et al., A multicenter randomized controlled trial of a nutrition intervention program in a multiethnic adult population in the corporate setting reduces depression and anxiety …, American Journal of … (2015).
[38] H.I. Katcher, et al., A Worksite Vegan Nutrition Program Is Well-Accepted and Improves Health-Related Quality of Life and Work Productivity, Annals of Nutrition and Metabolism 56(4) (2010) 245-252.
[39] A. Rosi, et al., Body weight of individuals with obesity decreases after a 6-month high pasta or low pasta Mediterranean diet weight-loss intervention, Nutr Metab Cardiovasc Dis 30(6) (2020) 984-995.
[40] C. Kerksick, et al., Effects of a popular exercise and weight loss program on weight loss, body composition, energy expenditure and health in obese women, Nutr Metab (Lond) 6 (2009) 23.
[41] J. Khoo, et al., Comparing the effects of meal replacements with reduced-fat diet on weight, sexual and endothelial function, testosterone and quality of life in obese Asian men, Int J Impot Res 26(2) (2014) 61-6.
[42] M. Lemstra, M.R. Rogers, The importance of community consultation and social support in adhering to an obesity reduction program: results from the Healthy Weights Initiative, Patient Prefer Adherence 9 (2015) 1473-80.
[43] C.M. Jenkinson, et al., Effects of dietary intervention and quadriceps strengthening exercises on pain and function in overweight people with knee pain: randomised controlled trial, BMJ 339 (2009) b3170.
[44] G. D'Eramo Melkus, et al., The effect of a diabetes education, coping skills training, and care intervention on physiological and psychosocial outcomes in black women with type 2 diabetes, Biological Research for Nursing 12(1) (2010) 7-19.
[45] C.D. Samuel-Hodge, et al., A randomized trial of a church-based diabetes self-management program for African Americans with type 2 diabetes, Diabetes Educ 35(3) (2009) 439-54.
[46] S. Lemoine, et al., Effect of weight reduction on quality of life and eating behaviors in obese women, Menopause (New York, N.Y.) 14(3) (2007) 432-440.
[47] E. Riesco, et al., Impact of weight reduction on eating behaviors and quality of life: Influence of the obesity degree, Obes Facts 2(2) (2009) 87-95.
[48] U. Agarwal, et al., A multicenter randomized controlled trial of a nutrition intervention program in a multiethnic adult population in the corporate setting reduces depression and anxiety and improves quality of life: the GEICO study, Am J Health Promot 29(4) (2015) 245-54.
[49] G.D. Foster, et al., The effects of a commercially available weight loss program among obese patients with type 2 diabetes: a randomized study, Postgraduate … (2009).
[50] A.T. Wade, et al., A Mediterranean Diet with Fresh, Lean Pork Improves Processing Speed and Mood: Cognitive Findings from the MedPork Randomised Controlled Trial, Nutrients 11(7) (2019).
[51] A.T. Wade, et al., A Mediterranean diet supplemented with dairy foods improves mood and processing speed in an Australian sample: results from the MedDairy randomized controlled trial, Nutr Neurosci 23(8) (2020) 646-658.

[52] A. Calegari, et al., Malnourished patients on hemodialysis improve after receiving a nutritional intervention, J Bras Nefrol 33(4) (2011) 394-401.
[53] L. Packel, et al., Cancer-related fatigue and deconditioning: a program evaluation, Rehabilitation Oncology 24(2) (2006) 3-8.
[54] E. Marcos-Forniol, et al., Secondary prevention programme of ischaemic heart disease in the elderly: A randomised clinical trial, Eur J Prev Cardiol 25(3) (2018) 278-286.
[55] L.E. O'Connor, et al., Adopting a Mediterranean-Style Eating Pattern with Different Amounts of Lean Unprocessed Red Meat Does Not Influence Short-Term Subjective Personal Well-Being in Adults with Overweight or Obesity, J Nutr 148(12) (2018) 1917-1923.
[56] M. Holst, et al., Telephone follow-up of self-care behaviour after a single session education of patients with heart failure in primary health care, Eur J Cardiovasc Nurs 6(2) (2007) 153-9.
[57] J.K. Kim, et al., Effectiveness of a comprehensive blood pressure control program in primary health care in Peru, Rev Panam Salud Publica 44 (2020) e12.
[58] L.A.R. Group, Impact of intensive lifestyle intervention on depression and health-related quality of life in type 2 diabetes: the Look AHEAD Trial, Diabetes care (2014).
[59] A.J.R.B. Costa, S.L. Pinto, Binge Eating Disorder and Quality of Life of Candidates to Bariatric Surgery, ABCD, Arq. bras. cir. dig. 28 (2015) 52-5.
[60] S. Sockalingam, et al., The relationship between eating psychopathology and obstructive sleep apnea in bariatric surgery candidates: A retrospective study, International Journal of Eating Disorders 50(7) (2017) 801-807.
[61] A. Cezaretto, et al., Benefits on quality of life concomitant to metabolic improvement in intervention program for prevention of diabetes mellitus, Qual Life Res 21(1) (2012) 105-13.
[62] C.R. Pacanowski, et al., Psychological status and weight variability over eight years: Results from Look AHEAD, Health Psychol 37(3) (2018) 238-246.
[63] S. Royal, et al., Night eating and loss of control over eating in bariatric surgery candidates, J Clin Psychol Med Settings 22(1) (2015) 14-9.
[64] A.R.G. Look, et al., Changes in mood and health-related quality of life in Look AHEAD 6 years after termination of the lifestyle intervention, Obesity (Silver Spring) 29(8) (2021) 1294-1308.
[65] F. Represas-Carrera, et al., Effectiveness of a multicomponent intervention in primary care that addresses patients with diabetes mellitus with two or more unhealthy habits, such as diet, physical activity or smoking: Multicenter randomized cluster trial (eira study), International Journal of Environmental Research and Public Health 18(11) (2021).
[66] A. Gholami, et al., Household Food Insecurity is Associated with Health-Related Quality of Life in Rural Type 2 Diabetic Patients, Arch Iran Med 20(6) (2017) 350-355.
[67] C. Lesk, et al., Influence of extreme weather disasters on global crop production, Nature 529(7584) (2016) 84-87.