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Dietary patterns: a literature review of the methodological characteristics of the main steps of the multivariate analyzes

Padrões alimentares estimados por técnicas multivariadas: uma revisão da literatura sobre os procedimentos adotados nas etapas analíticas

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ABSTRACT: ***Objective:*** To describe the solutions adopted in the multiple steps of the use of multivariate techniques to obtain a dietary pattern (DP) concerning: the objective of the studies, the selection of the method for measuring food intake, the criteria for grouping the foods, the number of food groups used, the number of DP obtained, and the nomenclature criteria. ***Methods:*** The articles were selected from MEDLINE and Lilacs scientific databases using the following keywords: "dietary patterns" *versus* "factor analysis"; "principal components analysis"; "cluster analysis" and "reduced regression rank." The initial search resulted in 1,752 articles. After inclusion and exclusion criteria, 189 publications were selected. ***Results:*** The following aspects were relevant among the studies: the prevalence of the principal component analysis (PCA); the prevalence of the use of 4 to 5 DPs in the studies of association with health outcomes; the use of 30 or more food groups from the food frequency questionnaire (FFQ); the prevalence of studies that associated DPs with health outcomes and socioeconomic factors; and the heterogeneity of criteria used throughout the analytical stages of the multivariate techniques. ***Conclusion:*** The heterogeneity between the publications concentrates on the criteria for food grouping, the nomenclature, and the number of dietary patterns calculated, which varied depending on the number of food groups present in these analyses. To understand, apply, and explore in full, the multivariate techniques has become necessary in order to improve the reliability of the results and, consequently, to improve the relationships with health outcomes and socioeconomic factors.

Keywords: Principal component analysis. Factor analysis, statistical. Multivariate analysis. Cluster analysis. Food consumption. Feeding behavior.

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RESUMO: ***Objetivo:*** Descrever as soluções adotadas nas múltiplas etapas de utilização das técnicas multivariadas para obtenção de padrão alimentar (PA) no que tange: ao objetivo dos estudos, à escolha do método de aferição do consumo alimentar, aos critérios de grupamento dos alimentos, à quantidade de grupos alimentares utilizada, ao número de PA extraído e aos critérios para nomenclatura. ***Métodos:*** Foram selecionadas publicações das bases MEDLINE e Lilacs tendo como descritores: "padrão alimentar" *versus* "análise fatorial"; "análise de componentes principais"; "análise de *cluster*" e "*reduced regression rank*". A busca inicial resultou em 1.752 artigos, que após critérios de inclusão e exclusão somaram 189 publicações. ***Resultados:*** Foram relevantes entre os estudos os seguintes aspectos: a predominância da análise de componentes principais (ACP); a predominância no uso de 4 a 5 PAs nos estudos de associação com desfechos de saúde; o uso de 30 ou mais grupos de alimentos provenientes do Questionário de Frequência Alimentar (QFA); a predominância de estudos que associaram PAs com desfechos de saúde e fatores socioeconômicos; a heterogeneidade de critérios adotados ao longo das etapas analíticas das técnicas multivariadas. ***Conclusão:*** A heterogeneidade entre as publicações se concentra nos critérios de agrupamento dos alimentos, na nomenclatura e no número de padrões alimentares extraídos, que variou em função do número de grupos alimentares presentes nas análises. Entender, aplicar e explorar em sua totalidade as técnicas multivariadas tem se tornado necessário para melhorar a confiabilidade dos resultados e, consequentemente, aprimorar as relações com desfechos de saúde e fatores socioeconômicos.

Palavras-chave: Análise de componente principal. Análise fatorial. Análise multivariada. Análise por conglomerados. Consumo de alimentos. Comportamento alimentar.

INTRODUCTION

Multivariate analysis techniques are increasingly being used for inferences on the dietary pattern (DP) in nutritional epidemiology[1-3]. The DP is biologically important, because it summarizes the total diet, taking into account that the foods are consumed in complex combinations, with interactions and synergies between dietary constituents, and that the balance between the components of protective and risk foods may be important to determine the associations between diet and diseases[4].

Epidemiologically, the expression of nutrition as a DP widens the view on the food intake of the population by:

- allowing the identification of trends and the characterization of groups with similar eating behaviors[2];
- identifying the introduction of new eating habits[5];
- recognizing the cultural aspects of food and the food diversity in the different geographic regions[5];
- understanding the specific relationships between characteristic DPs and the morbidity and mortality profile in the population[6,7];
- allowing the development of dietary guidelines for populations adopting the foods, and not only the nutrients, as a reference[6,8].

In several studies, the DP denominated as western, unhealthy, or processed is characterized by including foods such as soft drinks, sweets, and processed foods and has been

associated with a lower quality of life of the populations in different cultures. On the other hand, the DP denominated as healthy, traditional, Mediterranean, and prudent is characterized by the presence of cereals, fruits, vegetables, and typical products of each culture and has been associated with a better quality of life[8-17].

Four multivariate techniques are frequently used to identify a DP: principal component analysis (PCA), factor analysis (FA), reduced regression rank (RRR), and cluster analysis[18]. In the PCA and FA, the structure of the relationships is established between the original variables that are expressed in latent variables, which synthesize the spectrum of food variance of the population[19]. The estimate of the DP from PCA and FA assumes the dimensionality reduction principle of the number of foods or food groups usually consumed by a population, and the data were collected by food frequency questionnaire (FFQ), 24-hour diet recall (24HR), or dietary records[19]. In the cluster analysis, the structure of the analyzed relations occurs between individuals, identifying groups of mutually exclusive persons (clusters) according to the food intake[20,21]. The RRR technique analyzes multiple health outcomes simultaneously as a function of food intake to compose the DPs[3].

The estimate of a DP by multivariate techniques is a complex procedure that involves multiple phases[22]: the method of measuring food intake, the criteria and references in the constitution of the food groups, the type of multivariate analysis more appropriate to the data set, and the objectives of the investigation. The DP number was calculated to represent the maximum variance explained by the initial set of data, the criteria for the extraction of DP (*eigenvalue* > 1, scree plot, among others), the degree of correlation between the food groups and the DP, the type of rotation (orthogonal and oblique)[23], and the form of characterizing the DP (nomenclature)[4]. Such decisions, not harmonic in most studies, limit the comprehension of the patterns and hinder its generalization or extrapolation to other contexts[24]. The increase in scientific production about DP demands literature reviews structured according to conceptual and operational aspects, which may contribute to the standardization of multiple stages, in order to provide a broad comparability between the studies. Therefore, this review had as an objective to describe the solutions adopted in the multiple steps of the use of multivariate techniques to obtain the DP regarding: the purpose of the studies, the selection of the method of measuring food intake, the criteria for grouping the foods, the quantity of food groups used, the calculated DP number, and the nomenclature criteria.

METHODS

CRITERIA OF SEARCH AND SELECTION OF THE ARTICLES

The literature review comprised a guiding question: how did the authors organize the procedures used in the multivariate analysis to estimate the DP?

For this review, we selected four multivariate techniques: PCA, FA, RRR, and cluster analysis. Scientific articles were selected in the indexed databases MEDLINE and Lilacs using the following keywords: "principal component analysis" AND "dietary pattern"; "principal

component analysis" AND "food pattern"; "principal component analysis" AND "eating pattern"; "factor analysis" AND "dietary pattern"; "factor analysis" AND "food pattern"; "factor analysis" AND "eating pattern"; "RRR" AND "dietary pattern"; "RRR" AND "food pattern"; "RRR" AND "eating pattern"; "cluster" AND "dietary pattern"; "cluster" AND "food pattern"; "cluster" AND "eating pattern". The keywords were selected in the database Health Sciences Descriptors (DeCS: http://decs.bvs.br/).

CRITERIA FOR INCLUSION AND EXCLUSION OF ARTICLES

The inclusion criteria were Portuguese, English, or Spanish languages; period: from 1980 to 2012; human beings as target audience; and original articles with the purpose to describe and/or associate the DP with health outcomes or socioeconomic factors.

The exclusion criteria were publications that extracted the DP using other statistical techniques; publications with the objective to discuss methodological aspects of the multivariate techniques; publications that mixed behavioral patterns (physical activity, sedentariness, and smoking) with DP; duplicate articles (same article in two different languages or same article selected from different descriptors); systematic and nonsystematic reviews, meta-analysis, clinical trials, and comparison between multivariate techniques; publications without sufficient information on the aspects assessed in this review; and publications not found in full. These exclusion criteria intended to focus the work on original studies that used multivariate techniques in the data analysis.

After the first sorting, the selected publications were analyzed by four researchers, each of them responsible for only one type of multivariate technique (PCA, FA, RRR, and cluster analysis). Then, two researchers reassessed all the publications by comparing and selecting each according to the predetermined criteria. The reevaluation followed this sequence: title, abstract, full text, literature selection, and author citation, during which no new results of complementary publications were generated.

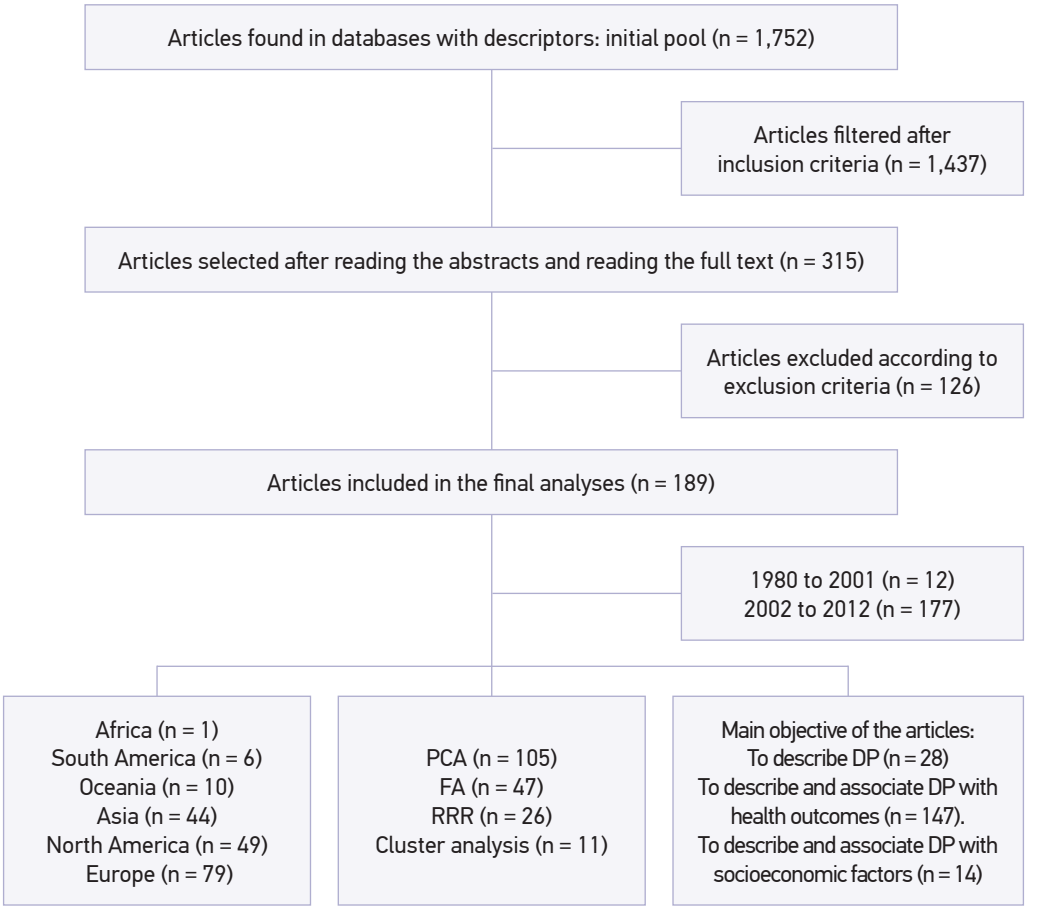
INFORMATION COLLECTED IN THE PUBLICATIONS

Of the 189 publications, the following aspects were picked: the period of production of the publications (organized in 10-year intervals); the continent of origin (classified as: North America, South America, Europe, Africa, Asia, and Oceania); the main purpose (to describe DP and/or associate it with health outcomes and socioeconomic factors); the health outcomes (*diabetes mellitus*, obesity, cardiovascular diseases (CVDs), cancer, and others); the method of collecting food intake data (FFQ, 24HR, and dietary record); the criteria for constitution of food groups (classified as: derived from the FFQ, official agencies/dietary recommendations/previous studies, nutritional composition, culinary use/consumption mode, and multiple); the amount of food groups included in the analyses (classified as: 10 to 19; 20 to 29; 30 to 39; ≥40 dietary/food groups); the calculated DP number (classified as:

<4, 4 to 5, 6 to 7, >7 DP or clusters, when it came to cluster analysis); and DP nomenclature (qualitative labels, based on the names of the foods, nutritional composition, and multiple).

RESULTS

Of the 189 analyzed publications, 56% (n = 105) mentioned the PCA technique to obtain the DP. Of the total publications, 42% (n = 79) were made in European countries, 26% (n = 49) in North American countries, and remaining 32% in Asian countries, South America countries, African countries, and Oceanian countries. Regarding the main objective of the articles, 78% (n = 147) described the DP and associated it with health outcomes, the others only carried out a descriptive/exploratory study of the DP and or associated it with socioeconomic factors (Figure 1).



DP: dietary pattern; PCA: principal component analysis; FA: Factorial analysis; RRR: reduced regression rank.
Figure 1. Descriptive chart of the process of selecting the articles included in the study.

The publications found in the period from 2002 to 2012 accounted for 94% of the total publications. This information shows an increase of 15.7 times in the number of publications when compared with the period from 1980 to 2001. The growing use of multivariate analyses in nutritional epidemiology publications was similar in the five continents (Figure 2).

In Table 1, the main characteristics drawn from publications and their respective references in the reference list of the text are summarized. Among the 147 articles that described and associated the DP with health outcomes, 64% (n = 94) used chronic noncommunicable diseases (CNCDs) as the outcome, of which 28% were obesity (n = 26), 27% CVD (n = 25), 29% cancer (n = 27), and 17% diabetes mellitus (n = 16) (Figure 1). Of the 147 publications that described the DP and associated it with health outcomes, there was a prevalence in the selection of the PCA technique in 55% of the cases (n = 81).

Of the total of analyzed articles, 81% (n = 154) used the FFQ as data collection method for food intake. Concerning the criteria used to group the foods obtained from collecting food intake data (step before the input of data in the multivariate techniques), 22% (n = 42) used preexisting groups from the FFQ, 14% (n = 26) adopted as a criterion the nutritional composition, 26% (n = 46) did not present any information about the used criteria, and remaining 38% (n = 75) reported: official agencies/dietary

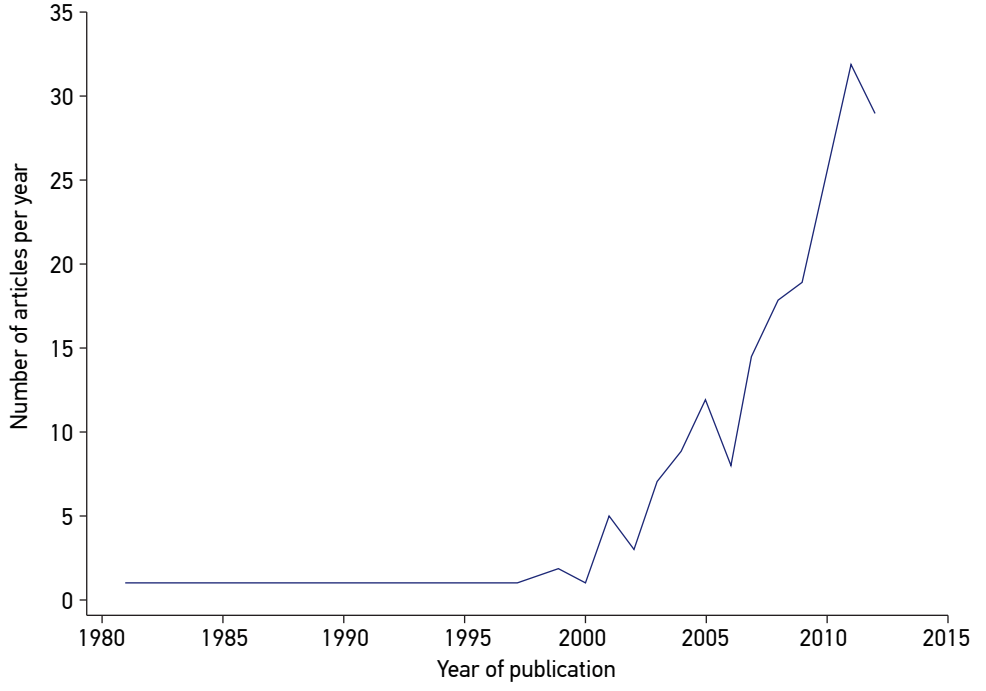


Figure 2. Evolution of the publications involving multivariate analysis for the constitution of dietary patterns in nutritional epidemiology in the period from 1980 to 2012.

Table 1. Classification of the articles identified in the review according to the main characteristics analyzed and the type of multivariate analysis: factor analysis, principal component analysis, cluster, and reduced regression rank.

Characteristics highlighted in the studies	PCA n (%)	FA n (%)	RRR n (%)	Cluster n (%)	Total (n)	Reference number of the articles in the reference list
Health outcomes						
Diabetes	7 (44)	3 (19)	5 (31)	1 (6)	16	(1,25–37)
Obesity	15 (58)	5 (19)	5 (19)	1 (4)	26	(38–62)
CVD	12 (48)	5 (20)	6 (24)	2 (8)	25	(63–84)
Cancer	18 (67)	8 (30)	1 (4)	0 (0)	27	(85–111)
Other diseases**	29 (55)	13 (24)	8 (15)	3 (6)	53	(112–163)
Data collection method for food intake						
FFQ	87 (56)	40 (26)	20 (13)	7 (4)	154	(25–37,39–41,44–48,51–56,59,60,62–74,76,78,80–95,97–99,101–109,111,112,115–120,124,125,127,129–142,144–147,150–152,154-155,157–161,163–197)
24HR	9 (60)	3 (20)	1 (7)	2 (13)	15	(38,49,61,75,77,114,126,128,148,149,156,188,198–200)
Dietary record	9 (45)	4 (20)	5 (26)	2 (10)	20	(42,43,50,57,58,79,96,100,110,113,121–123,143,153,162,201–204)
Criteria for grouping foods						
Groups derived from FFQ	24 (57)	11 (26)	5 (12)	2 (5)	42	(32,36,53,55,56,59,65–67,69,70,73,78,81,84,85,91, 93,95,104,106,109,130,135,139,140,142, 145–147,154,155,159,160,170,181–183,187,193,194)
Official agencies/dietary recommendations/previous studies	10 (50)	2 (10)	5 (25)	3 (15)	20	(27,39,46,57,61,94,100,114,116,137,150,153,162,164,165,174,198–200,202)
Nutritional composition	17 (65)	6 (23)	1 (4)	2 (8)	26	(34,43,44,47,54,62,72,75,90,97,99,102,119,125, 129,136,138,144,184,188,191,192,196,205)
Culinary use/consumption mode	13 (76)	0 (0,0)	1 (6)	3 (18)	17	(50,63,64,74,77,83,87,89,98,112,113,118,123,131,148,158,185)
Multiples*	18 (51)	12 (34)	5 (14)	0 (0)	35	(25,26,37,40,42,51,52,59,71,86,88,92,101,103,105,107,108,111,115,120,121,124,126,134,167,168,171,172,180,186,189,190)
Quantity of food groups in the analysis						
10 to 19	16 (55)	7 (24)	3 (10)	3 (10)	29	(34,36,47,60,64,82,102,110,112,118,126,127,133, 137,144,147,148,151,157,158,175,180,190,200,205,206)
20 to 29	20 (71)	3 (11)	2 (7)	3 (11)	28	(45,51,53,61–63,72,83,85, 99,108,111,114,119,129,136,138,142, 149,150, 164,172,187,191,193,198,203,204)

Continue...

Table 1. Continuation.

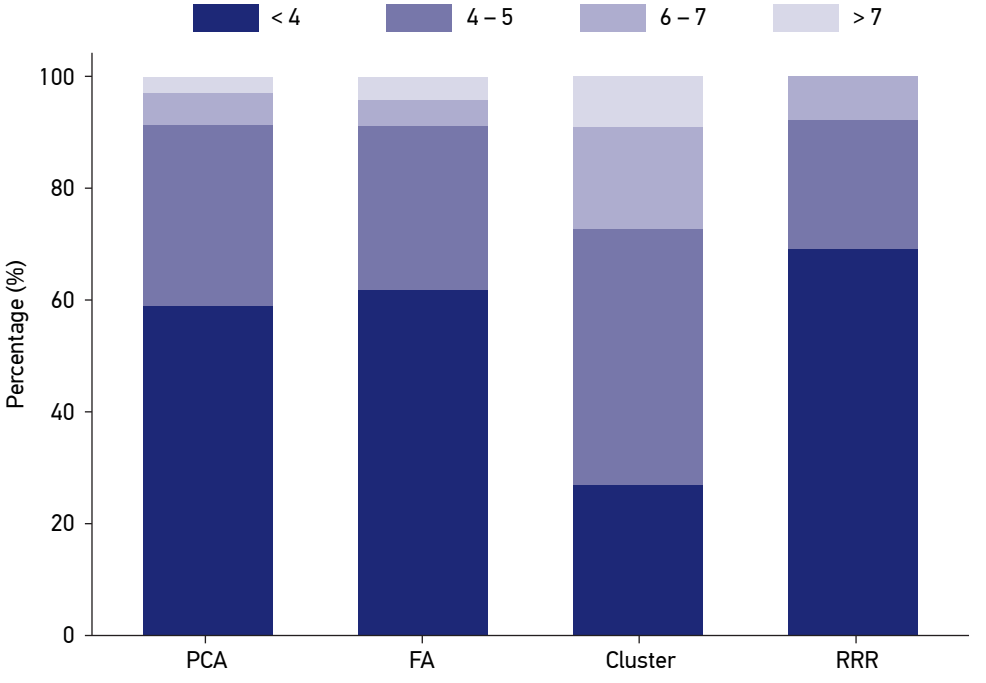
Characteristics highlighted in the studies	PCA n (%)	FA n (%)	RRR n (%)	Cluster n (%)	Total (n)	Reference number of the articles in the reference list
30 to 39	30 (52)	19 (33)	7 (12)	2 (3)	58	(25,26,32,40,41,48,50,52,54,56,59,65,69,74–76,78,79,81,86,88,90, 92–94,98,101,103–105,121,123,128,135,141,146,152,154, 160–163,166,176,178,183–186,188,189,192,196,197,199)
≥40	39 (53)	18 (24)	14 (19)	3 (4)	74	(27–31,33,35,37–39,42–44,46,55,57,58,66–68,70,71,73,77,80,84,87,89,91, 95–97,100,106,107,109,113,115–117,120,122,124,125, 130–132,134,139,140,143,145,153,155,156,159,165, 167–171,173,174,177,179,181,182,194,195,202)
Number of calculated dietary patterns						
<4	62 (55)	29 (26)	18 (16)	3 (3)	112	(25–37,39,40,43,44,50–52,54,57, 60,63,64,66–68, 70,74–76,78,79,81–83,86–88,90,91, 94–98,101–103,105,106,108,111,115,116,118,122,125, 127,128,131–133, 135–139, 144,145,147,149–152, 154–157,159–161,164,166,168,169,172,173,175,176,178,183,184, 186–192,195,197,202,203,205,206)
4 to 5	34 (58)	14 (24)	6 (10)	5 (8)	59	(41,42,45,47,48,53,55,56,59,61,62,69,71,73,77, 85,89,92,93,99,100,104, 112,113,117,119–121,123,124,129,130,134,140,142,143,146,148,153, 158,162,163,165,167,170,171,174,177,179–181,185,193,194,199,204)
6 to 7	6 (50)	2 (17)	2 (17)	2 (17)	12	(38,46,58,65,107,110,114,141,182,196,200)
> 7	3 (50)	2 (33)	0 (0)	1 (17)	6	(72,80,84,109,126,198)
Standard nomenclature						
Qualitative labels	55 (65)	18 (21)	5 (6)	6 (7)	84	(31,33,36-37,40,42,44–47,51,55,57,60,63–66,68,74,78, 81–83,86,87,90,91,96,97,103,105,108,111,112,115,118,120,125, 131–133,135,138–140,142,145–147,150–152,155,157–159,161,164–166, 168,170,174–176,178,179,183,184,186–188,190–193,198,199,204,205)
On the basis of the names of the foods	25 (42)	14 (24)	17 (29)	3 (5)	59	(26,27,29,30,32,34,35,38,39,43,50,52,54,56, 58,59,61, 62,67,72, 76,79,80,84,85,89,94,98,100–102, 104,106,107,110,116,117,122, 126–129,137,149,153,154,173, 177,180,188,189,195,196,200,202,203,206)
Nutritional composition	3 (43)	2 (29)	2 (27)	0 (0)	7	(75,95,99,141,167,197)
Multiples*	22 (56)	13 (33)	2 (5)	2 (5)	39	(28,36,41,48,53,69–71,73,77,88,92,93,109,113,114,119,121,123,124, 130,134,136,143,144,148,156,160,162,163,169,171,172,181,182,185,192,194)

PCA: principal component analysis; FA: factor analysis; RRR: reduced regression rank; CVD: cardiovascular diseases; FFQ: Food Frequency Questionnaire; 24HR: 24-hour dietary recall. *Combination of two or more criteria within the same characteristic. **Risk of skin lesion by arsenic; anthropometric alterations; plasma adiponectin levels; risk of pre-eclampsia; growth of newborns; asthma; anemia; C-reactive protein; constipation; osteoporosis; hyperactivity; risk of stroke; Alzheimers disease; risk of spina bifida in newborns; mortality; mental health (depression, stress, attention deficit', and bipolar disorder); and more than one health outcome.

recommendations, culinary use / consumption mode and multiple criteria. With respect to the total of food groups included in the analyses, 70% (n = 132) reported working with 30 or more food groups (Table 1).

In the techniques where there is multiple attribution of components per individual (PCA, FA, and RRR), the calculation of up to 4 components was prevalent and reached 59% (n = 62) of the total of articles that have addressed these techniques. In the cluster analysis, when there is only one attribution of component per individual, the extraction of 4 to 7 components per analysis reached 73% of the analyzed articles (Figure 3).

In the DP nomenclature, the qualitative labels category (for instance, traditional, healthy, and western) was used in 44% of studies (n = 84); the name of the foods category (for instance: fruits, meats, cereals, breads, legumes, and vegetables), in 31% (n = 59); the nutritional composition categories (for example, fibers, trans fat, fatty acids, and vitamins), or multiple criteria were used in 24% of the studies (n = 46) (Table 1).



Cluster: cluster analysis. The number of dietary patterns calculated using the RRR technique depends on the number of outcomes included in the analysis.
PCA: principal component analysis; FA: factor analysis; RRR: reduced regression rank.

Figure 3. Number of estimated dietary patterns according to the multivariate technique adopted: principal component analysis, factor analysis, cluster and reduced regression rank in the period from 1980 to 2012.

DISCUSSION

In the period between 1980 and the first half of the 1990s, the frequency of the studies on DP remained relatively low, even with good quality publications. In 1998, Slattery et al.,[207] introduced the FA to obtain DP and its association with colon cancer, raising the provocative question "can eating patterns characterize the risk of diet *versus* disease better than isolated nutrients and foods?"

The scope of the use of multivariate analysis enables us to give a partial answer to this question, because the description of dietary patterns and their relationship with health outcomes intensifies from the 2000s on. This expansion occurs in parallel with the evolution of the epidemiological profile, in which the frequency of multicausal diseases linked to nutrition has an increasingly relevant role in nutritional epidemiology. The review carried out by Hu[2] contributed to disseminate and encourage the use of DP analysis through multivariate techniques as an alternative and a complementary approach in the research of the association between diet and CNCDs.

From the authors' knowledge, this is the first review that discussed how authors organized the procedures used in the multivariate analysis to estimate the DP. The main findings of this review were: predominant use of PCA and FA; use of 4 to 5 factors when the DP is associated with health outcomes; use of 30 or more food groups from the FFQ; prevalence of association studies of DP *versus* health outcomes or socioeconomic factors; and heterogeneity of the criteria adopted along these steps.

The PCA and the FA are different multivariate techniques regarding the exploration of the variability and the foundation of the estimator; nevertheless, they are usually quoted without respecting the methodological differences that distinguish them[208]. Owing to the deterministic nature of the PCA, the estimated dietary patterns represent the spectrum of the eating behavior in a given population. This estimate is based on the premise that the instruments and the data collection process must have a random error and of small magnitude[2]. The probabilistic nature of FA, in its turn, enables the analytical treatment of the error embedded in the data survey, a relevant aspect when we resort to dietary questionnaires to translate the dietary behavior of populations[209]. The RRR has the particularity of allowing the selection of the DP to occur directly from the maximization of the association between the dietary variables and the markers of the outcome of interest[206,210]. The cluster analysis can be methodologically distinguished from the others by having as an objective to group the individuals into hierarchical clusters according to the level of dissimilarity between the components of the diets of the individuals[211].

The choice of the same food groups found in the FFQ predominated in the searched publications. This selection increases the internal consistency of the analyses, because it uses the data from previously validated instruments that had their food groups constituted as a function of the outcome under study. In the studies in which 24HR or dietary records were used, the predominant criteria for the formation of food groups were: nutritional

composition, groups previously classified by official agencies, government nutritional recommendations, and foods drawn from national surveys.

The analytical design and the number of selected variables involve subjectivity and arbitrariness of the researcher and cause multivariate analysis to be of difficult reproducibility, to the detriment of the comparability across studies. The inclusion of a large number of uncorrelated variables may have an erroneous effect on the determination of the variance explained by that DP, while the elimination of variables in order to simplify the factor structure can lead to mistaken conclusions[24]. In the studied publications, the use of 30 or more groups of food was verified, probably because 76% of the articles assessed food intake through FFQs, which, in most cases, have a large number of food items and/or groups, enabling later, in the multivariate analysis, greater precision and accuracy of the obtained DP[212].

The number of food groups included in the multivariate techniques interferes greatly in the proportion of the variance explained by the factors and the number of factors to be retained, especially by the latent root criterion (*eigenvalue*). The greater the explained variance, the better is the understanding of the diversity and complexity of the nutrition of the analyzed population[19].

In this review, the studies that associated DP with CVD and cancer have used fewer than four DPs to explain the possible relations of risk or protection, while those that associated obesity with DP used four to five factors. Studies carried out by Schulze et al.[213] and Brennan et al.[214] found that the use of up to three factors enables good associations with health outcomes. In the cluster analysis, Newby and Tucker[4] found good associations with CNCDs in the presence of two to eight clusters, a fact that was observed in this review. The number of obtained DPs is linked to the percentage of variance explained by them, and the aim is to explain the higher variance of the initial set of data with a minimal number of factors or clusters[215].

For the studies that designated qualitative label to the DP, we verified an empirical basis in the sense of finding meaning in the available scientific information. Thus, it was possible to find a similarity in the type of food that composed these patterns. Patterns named as "traditional" contained preparations more prevalent of the diet of the country where the study was conducted. Those labeled as "healthy pattern" and "prudent pattern" contained vegetables, fruits, whole grains, fish, low-fat dairy products, chicken, and soybean and byproducts. The label "Mediterranean pattern" is characterized by grouping pasta, rice, fish, legumes, vegetable oils, skim milk, salads, fruit, wine, and cucumber, while the "western pattern" is characterized by soft drinks, pizza, hamburger, processed meats, sugary drinks, whole milk, precooked foods, refined grains, bacon, and ham.

In this literature review, one should take into account some limitations. The first stems from the fact that the selection of articles was carried out in two scientific databases: MEDLINE and Lilacs. The fact that these two databases compile vast amount of indexed scientific articles and with good quality tends to reduce the possible effects caused by the restriction in the number of databases consulted. The second was the selection of

three languages (English, Portuguese, and Spanish) for the search process, which may also have reduced the number of publications found. However, the authors conducted a survey in these two bases using the same descriptors of the study, without language restriction, and it was verified that the loss of publications owing to language would not exceed 5%. The third is related to the fact that, even if constructed broadly, the initial question does not address typically operational aspects for constructing DP, for example, types of rotation, methods used in the calculation of DP, qualitative or quantitative variable, and sample size, among others.

The use of multivariate techniques has advanced in the last decade, highlighting the importance of the standardization of the published information. In this review, we verified cases where the DP was characterized and interpreted according to the most prevalent nutrients among the food groups that compose it[43,60,107,153,216]. This form of interpretation focused on a single nutrient or set of nutrients that mischaracterize the DP, to the extent that it ceases to evaluate the complexity of the diet expressed by the combination of foods. A favorable evidence to the full use of the DP and its interpretation based on the foods that compose it, and contrary to the tradition of selecting nutrients more associated with the outcome, is the tendency of increase in the variance explained by the patterns as the detailing of the dietary information decreases[215].

CONCLUSION

The use of the multivariate techniques in nutritional epidemiology has increased in recent decades mainly owing to the need to learn and represent the food intake in its complex form, taking into account the interaction between the nutrients present in the foods. We verified, among the publications, the prevalence of the techniques in which the structure of relations is based on variables (PCA and FA) and not on individuals (cluster). In this review, the heterogeneity of the studies concentrates mainly on the criteria for grouping the foods that preceded the use of multivariate techniques and on the criteria for naming the calculated DPs. The grouping of the foods directly affects the number of calculated patterns and the interpretation and elucidation of the association of the DP with health outcomes. To understand, apply, and explore in full, the multivariate techniques have become necessary to improve the reliability of the analytical studies about DP and, hence, to refine the relations with health outcomes and socioeconomic factors.

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ETHICS COMMITTEE

The study is part of C.A.B's doctoral project, which was submitted to the Research Ethics Committee of the School of Public Health at Universidade de São Paulo, and, because it uses secondary databases, does not require approval (CAAE 0129.0.207.000-11/process no. 2315).

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