REVIEW

A Systematic Review of Literature on the Representation of Racial and Ethnic Minority Groups in Clinical Nutrition Interventions

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ABSTRACT

The racial and ethnic disparities in diet-related chronic diseases are major concerns. This systematic review examines the extent to which diet-induced changes in health outcomes, such as cardiometabolic, inflammation, cancer, bone health, and kidney function outcomes, etc., have been reported and discussed by race or ethnicity in randomized trials with 2 or more diet arms that recruited both minority and non-Hispanic White groups. Databases (i.e., PubMed, Cochrane Library, and Web of Science) were searched up to August 2021. Thirty-four studies that discussed effects of defined dietary interventions on health outcomes by racial or ethnic minority group compared with non-Hispanic Whites were included in the systematic review (PROSPERO registration number: CRD42021229256). Acute trials and those with 1 diet arm that accounted for race or ethnicity in their analyses and studies that focused on a single racial or ethnic group were discussed separately. Most studies were conducted in Black compared with White adults testing effects of energy restriction, macronutrient modification, sodium reduction, or variations of the Dietary Approaches to Stop Hypertension (DASH) diet on cardiometabolic outcomes. There was limited focus on other minority groups. Evidence suggests greater blood pressure reduction for Black adults compared with Whites particularly with DASH (or similar) diets. Overall, there was limited consideration for group-specific eating patterns and diet acceptability. Overall risk of bias was low. With emerging precision nutrition initiatives that aim to optimize metabolic responses in population subgroups through tailored approaches, it is imperative to ensure adequate representation of racial and ethnic subgroups for addressing health disparities. Factors that help explain variability in responses such as socioecological context should be included and adequately powered. Given the racial and ethnic disparities in chronic diseases, studying the adoption, maintenance, and effectiveness of dietary interventions on health outcomes among different groups is critical for developing approaches that can mitigate diet-related health disparities. *Adv Nutr* 2022;13:1505–1528.

Statement of Significance: To our knowledge, this review is the first to report on clinical nutrition research on ethnic and racial minority groups in countries with predominantly non-Hispanic White populations. The review recognizes the need for adequate representation of ethnic and racial minorities in future studies with inclusion of socioecological factors.

Keywords: health disparities, underrepresented groups, diet, race, food environment

Introduction

Racial and ethnic minority groups are understudied in clinical research (1–5), despite comprising approximately 40% of the US population (6). This is particularly concerning given the higher prevalence of major chronic diseases among these groups (7). For example, in comparison to non-Hispanic White adults, non-Hispanic Black adults are 1.3 times more likely to have hypertension (8), 1.6 times more likely to have diabetes, and 1.3 times more likely to have obesity (9). Hispanic adults are 1.7 times more likely to have diabetes (10) and 1.2 times more likely to have obesity (9) than non-Hispanic Whites. Moreover, despite lower body weights (11), Asian Americans are 1.4 times more likely to have diabetes (10) than non-Hispanic Whites. However, differences by racial and ethnic subgroups should be noted. For example, Mexican Americans and non-Hispanic Asians have higher adiposity and metabolic syndrome at the same BMI than other groups within their corresponding ethnic categories (12). Among Hispanic adults, Mexican Americans have the highest prevalence of total diabetes (24.6%), and South

American subgroups have the lowest prevalence (12.3%) (13). Puerto Ricans have the highest years of potential life lost due to cardiovascular disease compared with Mexicans and Cubans (14). Among non-Hispanic Asian adults, South Asians have the highest prevalence of total diabetes (23.3%), and East Asians have the lowest (14%) (13). Evidence suggests that diet-related disparities contribute to greater disease burden in some racial and ethnic minority groups (15).

Diet-related disparities are often defined as high saturated fat and salt intake and low fruit, vegetable, and whole-grain intake, resulting in suboptimal nutrient profiles (15). Non-Hispanic Black adults are less likely to meet the recommended intake of fruits and vegetables compared with White adults (16, 17). There are also disparities within racial and ethnic subgroups. For example, in the Hispanic Community Health Study, the traditional white rice, beans, and red meats dietary pattern was associated with poorer diet quality in Cuban and Central American groups but higher diet quality in Mexicans (18). Moreover, US-born Black adults report higher energy, total fat, and saturated fat intake and lower fiber intake compared with non–US-born Black adults (19). Although South Asians have higher diet quality than Chinese Americans, Whites, Hispanics, and African Americans, paradoxically they also bear higher rates of diabetes and cardiovascular disease (20). This suggests that nondietary factors impact health disparities. Genetic predisposing factors may contribute to the increased prevalence of cardiometabolic diseases among these groups (21). However, these disparities more often result from interactions of genetic variants with environmental factors (22) and diet (23, 24). Poor diet quality can exacerbate the expression of the genes involved in metabolic dysfunction, such as insulin resistance (25). Importantly, food choices are influenced by environmental and contextual factors. It is documented that ethnic and racial minority groups are systematically exposed to physical, social, economic, and political environments that hinder their ability to sustain healthful choices, including consistent consumption of nutritious food (26–32). The dietary practices of immigrant groups, in particular, is determined by the extent to which they are able and willing to retain the cultural practices of their country of origin and to adopt and adapt to the food environment of the new country (33–37). Consistent evidence indicates that recent immigrants in the United States exhibit better diet quality, a phenomenon often mediated by socioeconomic factors (20, 38, 39).

Recognizing the cultural and contextual factors that distinctively inform the food choices and eating practices of ethnic and racial minorities in nutrition research is paramount to designing effective dietary interventions. This is in line with the stated research priority of the American Society of Nutrition of determining the variability in responses to diet and food components by population subgroups, including ethnic and racial minority groups (40). Hence, the primary purpose of this systematic review is to report on clinical nutrition research on ethnic and racial minority groups in countries with predominantly non-Hispanic White populations. More specifically, the systematic review examines the extent to which diet-induced changes in health outcomes, such as cardiometabolic, inflammation, cancer, bone health, kidney function, etc., have been studied in randomized trials with 2 or more diet arms that report findings by race and/or ethnicity.

Methods

The study protocol is registered with PROSPERO, the International Prospective Register of Systematic Reviews (registration number CRD42021229256).

Search strategy

A comprehensive search strategy was developed in accordance with the Cochrane Handbook of Systematic Reviews (41). This strategy used a mixture of controlled vocabulary and natural language to reflect the focus of the analysis— to identify dietary studies that included racial and ethnic minority groups in clinical nutrition research trials (i.e., interventions examining diet effects on health-related outcomes in humans). The initial searches were conducted until 7 November 2019. Searches were updated on 30 August 2021 to capture studies published from 8 November 2019 to 30 August 2021. Complete search strategies are available in **Supplemental Table 1**. No restrictions were imposed on language, date of publication, or study design.

Study selection

The search was conducted across 3 databases (PubMed, Web of Science, and Cochrane Library) and the results were compiled in Zotero (version 5.0.87). Reference lists of related systematic reviews and meta-analyses were hand-searched to identify additional relevant articles. Three authors (JD, AGJ, SO) reviewed the articles in a systematic manner for inclusion in the review. Any discrepancies were resolved via a vote for inclusion.

In the first pass, the titles and the abstracts of articles were independently screened to identify potentially relevant articles based on the criteria. Articles were excluded if the studies *1*) were duplicates, *2*) were community-based or lifestyle interventions that were not controlled or the dietary intervention was not defined, *3*) included children or pregnant women, *4*) did not assess health outcomes, *5*) did not have full texts, or *6*) were published as conference abstracts. In the second pass, full texts of articles were screened and articles were excluded if the studies *1*) recruited exclusively non-Hispanic White groups, *2*) did not mention race or ethnicity, or *3*) were conducted in countries where

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Supplemental Tables 1–5 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances/.
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Abbreviations used: BP, blood pressure; DASH, Dietary Approaches to Stop Hypertension; RCT, randomized controlled trial; SBP, systolic blood pressure.

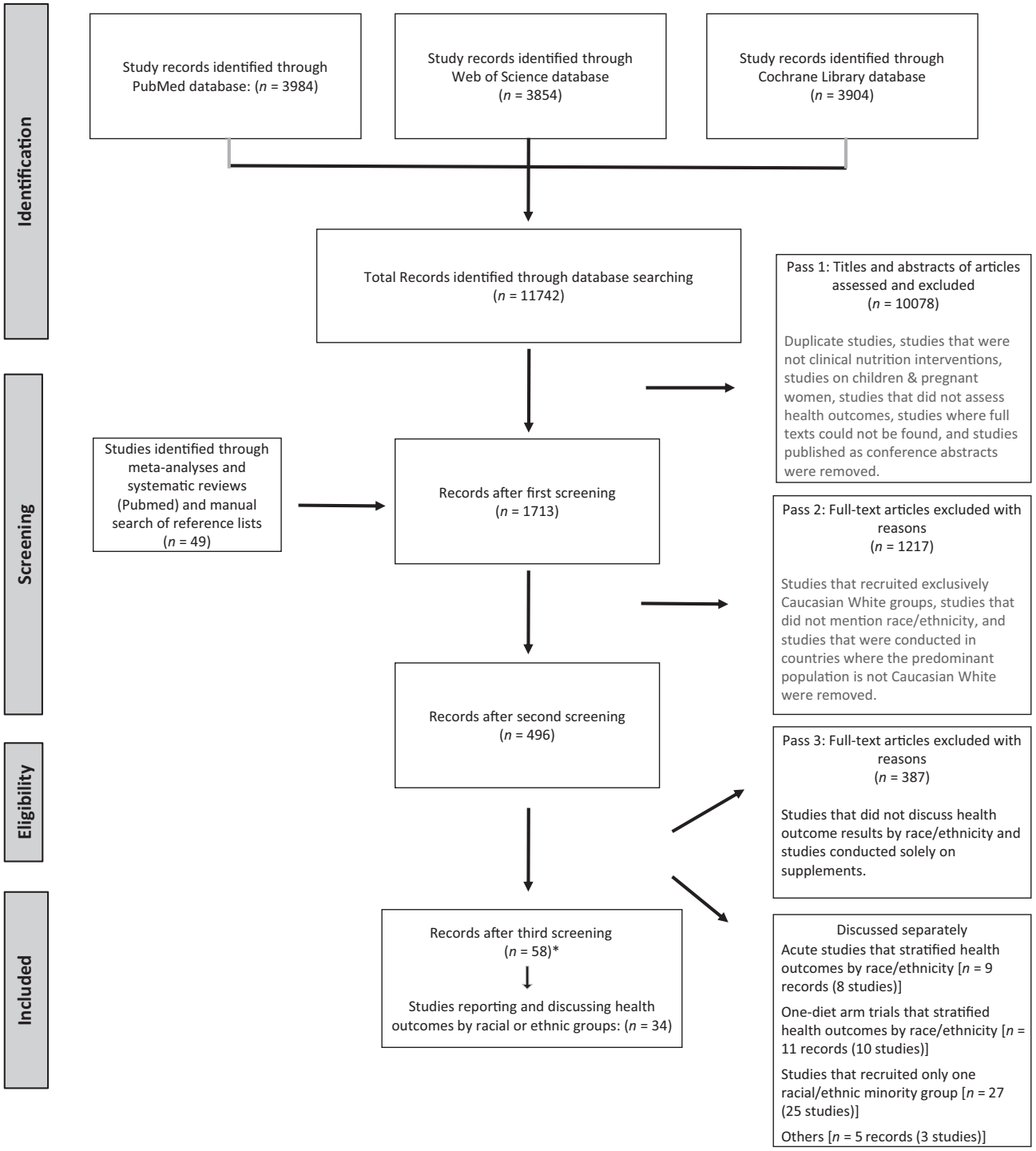

FIGURE 1 PRISMA flow diagram for the inclusion of studies in the systematic review examining the representation of ethnic and racial minorities in clinical nutrition interventions. *Several studies were published as multiple articles. One article (42) discussed 2 studies. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

the predominant population is not non-Hispanic White. In the third and final pass, only studies that discussed health outcomes by racial or ethnic groups were included in the systematic review. Clinical dietary interventions included in the final pass are defined as studies that manipulate the dietary composition of participants' diets via a specific dietary prescription or foods but not supplements or drugs. The study selection process is documented in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (**Figure 1**).

Data extraction

Data collection tables were developed by 1 author (JD) and variables were finalized in discussion with co-authors. Data extraction was completed by 2 authors (AGJ, SO) and was reviewed for accuracy by JD. The quality of each study article was assessed using the Oxford Centre for Evidence-Based Medicine Levels of Evidence (43). The risk of bias was evaluated with use of the Academy of Nutrition and Dietetics Quality Criteria Checklist (QCC) for Primary Research (44).

Results

In total, 11,742 records were screened for inclusion from database search and 49 from meta-analyses and systematic reviews and manual search of reference lists. A total of 11,682 records were excluded based on the established criteria (Figure 1). Thirty-four studies with 2 or more diet arms that discussed health outcomes, such as cardiometabolic outcomes, inflammation markers, cancer endpoints, bone health markers, and kidney function outcomes, etc., by racial and ethnic group were included in the systematic review. Some studies had multiple publications discussing different outcomes and are grouped together in **Table 1**. Twenty pertinent studies that accounted for race and/or ethnicity in their analyses were acute trials ($n = 8$; 9 records; **Supplemental Table 2**) (i.e., were measured the same day or within a short period of time) and 1-diet arms ($n = 10$; 11 records; **Supplemental Table 3**), and hence did not fully align with established criteria for inclusion in the systematic review but are discussed separately. Twenty-five studies (27 records) that focused on a single racial and ethnic group are also discussed separately (**Supplemental Table 4**). The few pertinent studies that did not fit the aforementioned categories are presented separately in **Supplemental Table 5**. The detailed inclusion and exclusion criteria are presented in Figure 1.

Study design and duration

Thirty-one studies were conducted in the United States, 1 in the United Kingdom (97), 1 in Denmark (85, 86), and 1 study was a multicenter trial conducted in Australia, Canada, and the United Kingdom (100). Included studies varied in design, duration, and dietary intervention tested (Table 1). Twenty studies (42, 55–76, 81, 84–86, 90–92, 94, 95, 98–102) were trials with a parallel design (2–5 arms), of which the longest trial had a duration of 8 y and the shortest trials had a duration of 4 wk. One study [i.e., the Dietary Approaches to Stop Hypertension (DASH)–Sodium Feeding study] was a 12-wk randomized, controlled interventional trial with a 2-arm parallel design and 30-d crossover diets nested within the 2 parallel groups (61–65). Fourteen studies (42, 45–54, 77–80, 82, 83, 87–89, 96, 103, 104) followed a crossover design in which participants were exposed to 2–5 dietary interventions, with interventions lasting between 1 wk and 6 mo.

Origin of ethnic and racial groups

Only a few studies indicated the geographic origin of the ethnic and racial minority groups. In most studies, Black adults were classified as African Americans. Some conducted genotyping to detect admixtures of African and European ancestry (78, 77). Among studies recruiting Asians, Garcia et al. (83) recruited Chinese-origin adults; studies by Maskarinec et al. (42, 95, 96) recruited Japanese, Filipino, and Chinese-origin adults; and a study conducted in Denmark recruited Pakistani adults (85, 86). Among studies with Hispanic participants, Perry et al. (91) and Hung et al. (92) recruited adults of Mexican origin while Puerto Ricans formed the major Hispanic group in another study (82). Others that classified groups by origin recruited Pima Indians (87) and West Indians (55).

Effects of dietary intervention on health outcomes by race or ethnicity

Most interventions were designed to modify the macronutrient composition of the diets and health outcomes largely included anthropometric markers (8 studies), blood pressure (BP; 12 studies), markers of glucose metabolism (8 studies), and lipids (13 studies) (Table 1). Study stratification by health outcomes is depicted in **Figure 2**.

Dietary interventions in Black or African American adults (vs. Whites) largely examined effects of the DASH diet, or effects of modifying the salt or fat content of the diets on anthropometrics, lipid profiles, insulin sensitivity, and BP (Table 1). Notable results include African Americans with hypertension showing greater mean arterial pressure and systolic BP (SBP) increase with salt loading than Whites (49). A few studies reported a smaller weight loss in Black adults compared with White adults with energy-restricted diets (60, 75, 90). The DASH diet study, which compared dietary patterns, and the DASH-sodium study, which compared different levels of dietary sodium, were 2 major studies that reported differential effects between Black and White groups. For example, analyses from the DASH study reveal greater reduction in SBP (69, 68), 24-h SBP (73), calcitriol (men only) (72), and coronary heart disease risk (71) with the DASH diet in Black compared with White adults. In the DASH-sodium study, the reduction in BP with lower sodium on the control diet was greater in Black adults than in Whites (61). The 24-h urinary potassium excretion at the highest sodium level with the DASH diet was lower for Black than for White adults (63).

Studies recruiting Asian, Hispanic, or Pima Indian participants largely examined the differential effects of race or ethnicity on anthropometrics and glucoregulatory and lipid profiles. Asian adults responded to a higher-fat (lower PUFA) compared with lower-fat and self-selected diets with increased total and VLDL cholesterol, whereas White adults responded to the lower-fat diet with decreased total, LDL, and VLDL cholesterol (83).

In another study, Asian adults gained less weight but had greater increase in HOMA-IR than White adults when transitioning from a traditional Asian diet to a typical Western diet (84). In 1 study, Hispanic and White adults

TABLE 1 Characteristics of studies included in the systematic review examining the representation of ethnic and racial minorities in clinical nutrition interventions[1]

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Black and White adults								
Branis et al. 2015 (45)	Crossover (2 groups)	1 wk	23 (12)	Black, White	Healthy premenopausal women (age: 25–45 y, BMI: 25-45 kg/m^2)	High-fat vs. low-fat diet	Insulin sensitivity and clearance	Black (vs. White): lower insulin clearance on both diets
Berk et al. 2006 (46)	Crossover (2 groups)	1 wk	42 (21)	Black, White	Healthy premenopausal and nondiabetic women (age: 22–44 y, BMI: 18.7–46.5 kg/m^2)	High-fat vs. low-fat diet	Macronutrient oxidation rates	White but not Black: higher fat oxidation and lower carbohydrate oxidation on high-fat vs. low-fat diet
King et al. 2007 (47)	Crossover (2 groups)	3 wk	35 (16)	Black, White	Lean normotensive and obese hypertensive men and women (age: 18–49 y, BMI: 28 ± 1 kg/m^2)	High-fiber DASH diet vs. fiber-supplemented diet (both 30 g/d)	CRP	Black (vs. White): similar DEC in CRP levels on both diets[8]
Gerhard et al. 2000 (48)	Crossover (2 groups)	4 wk	22 (13)	Black, White	Premenopausal women (age: 18–45 y, mean BMI: 34 kg/m^2)	Low-fat, high-fiber diet vs. high-fat, low-fiber diet	Plasma lipids	Black (vs. White) on high-fat, low-fiber diet: similar INC in plasma lipids
Wright et al. 2003 (49)	Crossover (2 groups)	7 d	199 (99)	Black, White	Normotensive and hypertensive women (age: 56 ± 8 y, BMI: 27 ± 4 kg/m^2)	High-salt diet vs. low-salt diet	BP	Black (vs. White) hypertensives: greater mean arterial pressure and SBP with salt loading[8]
Appel et al. 2005 (50) Furtado et al. 2010 (51) Kovell et al. 2020 (52)	Crossover (total 4: 3 groups and baseline)	6 wk	164 (90)	Black, White, Others	Prehypertensive and hypertensive men and women [age: 54 ± 11 (SD) y, BMI: 30 ± 6 (SD) kg/m^2]	Carbohydrate-rich vs. protein-rich vs. unsaturated-fat-rich diets	BP, lipids, Apo C-III-containing lipoproteins, hs-cTnI, hs-CRP	Black on protein (vs. carbohydrate) diet: DEC systolic BP (50)[8] Black and non-Black on unsaturated fat (vs. carbohydrate) diet: DEC systolic BP (50)[8] White on unsaturated fat and protein diets: DEC in apo C-III and triglyceride (51)[8] Black (vs. non-Black) on unsaturated fat diet: greater DEC in hs-cTnI (52)[8]
Howard et al. 1995a (53) Howard et al. 1995b (54)	Crossover (total 5: 4 groups and baseline)	6 wk	63 (34)	Black, White	Hypercholesterolemic men and women [age: 46 ± 10 (SD) y, BMI: 26 ± 4 (SD) kg/m^2]	Baseline diet (37% total fat, 15% saturated) vs. 4 reduced-fat diets (30% fat, 10% saturated fat) of varying PUFA (3%, 6%, 10%, and 14%) and MUFA (17%, 14%, 10%, and 6%) content	Lipid profile	Black (vs. White): INC in triglycerides on reduced-fat diets but similar DEC in total and LDL-C on reduced-fat diets (53)[8] No significant differences by race in response to varying PUFA/MUFA content of diets (54)

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TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Erlinger et al. 2002 (55) Conlin et al. 2003 (56)	Randomized (2 groups)	8 wk	55 (36)	Black, White	Hypertensive men and women [53 ± 9 (SD) y, BMI: 29 ± 5 (SD) kg/m^2]	DASH diet vs. control (+ Losartan)	Ambulatory BP (ABP), fibrinolysis markers	No significant effect of diet x race on markers of fibrinolysis (55) Black on DASH diet (vs. control diet) + Losartan: greater DEC in ABP (56)[8]
Prather et al. 2011 (57)	Randomized [2 groups for this analysis (originally 3 groups)]	4 mo	118 (43)	Black, White	Hypertensive men and women (SBP: 130–159; DBP: 85–99, age ≥ 35 y, BMI: 25–40 kg/m^2)	DASH diet vs. usual diet	BP	No significant diet × race effects Black on DASH diet (vs. control): improvement in SBP dipping postintervention[8] White on DASH diet (vs. control): no change in SBP dipping postintervention[8]
Goree et al. 2011 (58) Ellis et al. 2012 (59)	Randomized (2 groups)	8 wk	69 (33)	Black, White	Overweight or obese men and women (premenopausal) (age: 21–50 y, BMI: 25–46 kg/m^2)	Standard diet (STD; 55% carbohydrate, 27% fat) vs. reduced-carbohydrate/higher-fat diet (RED-CHO; 43% carbohydrate, 39% fat)	Insulin sensitivity, β cell responsiveness, ghrelin	Black : lower static β cell response to glucose with RED-CHO diet vs. STD diet (58)[8] White: similar static β cell response to glucose with RED-CHO diet and STD diet (58)[8] No effects of diet × race on ghrelin AUC (59) and insulin sensitivity (58)
Bales et al. 2017 (60)	Randomized (2 groups)	6 mo	78 (30)	Black, White, Other	Obese women (age: 60 ± 8.2 y, BMI: 37.8 ± 5.9 kg/m^2)	Control weight-loss (0.8 g protein/kg body weight) vs. high-protein weight-loss (1.2 g protein/kg body weight)	Weight	White (vs. Black): greater weight loss overall

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TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Vollmer et al. 2001 (61) Bray et al. 2004 (62) Turban et al. 2013 (63) Derkach et al. 2017 (64)[7] Murtaugh et al. 2018 (65)	Randomized (2 groups)/ Crossover (3 groups nested within the 2 main groups)	12-wk total (30 d each crossover period)	412 (234) (Original study)	Black, White	Men and women with untreated elevated or hypertensive BP [mean age 48 ± 10 (SD) y, BMI: 29 ± 5 (SD) kg/m^2]	DASH diet vs. control (typical US) diet (12 wk) Three sodium intake levels (30 d/level for each diet)	BP, urinary potassium excretion, metabolites (metabolomics analyses)	Black vs. White: greater reductions in BP with lower (vs. higher) sodium intake on control diet (61) Black vs. White on DASH diet: lower 24-h urinary potassium excretion at the highest sodium level (63) Black vs. White: Similar strong association of sodium with systolic BP at lower levels of energy intake (65) Only Black: Association of sodium and diastolic BP varied with energy intake (65) No effects of race on change in BP by diet (62)[8] No significant effects of race and diet covariates on changes in metabolomic profiles in response to sodium intakes (64)[8]
Appel et al. 2001 (66)[7]	Randomized [2 groups (4 in original study)]	Up to 3 y	639 (146)	Black, non-Black	Hypertensive men and women (age: 66 ± 5 y, median BMI: 28 kg/m^2)	Reduced sodium diet vs. usual lifestyle (control)	Urinary sodium excretion, BP	Black (vs. non-Black): Similar DEC in sodium excretion and BP on reduced sodium diet (vs. control)[8] Black: significant relative HR of endpoints (reduced sodium vs. control), i.e., 0.56[8]

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TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Appel et al. 1997 (67) Svetkey et al. 1999 (68) Sacks et al. 1999 (69) Obarzanek et al. 2001 (70)[7] Chen et al. 2010 (71)[7] Hassoon et al. 2018 (72)[7] Tyson et al. 2018 (73)[7] Juraschek et al. 2021 (74)[7]	Randomized (3 groups)	8 wk	459 (303) (Original study)	Black, White, Other	Hypertensive men and women with SBP<160 mm Hg and DBP = 80–95 mm Hg (mean age: 44 y, mean BMI: 28 kg/m^2)	Control diet vs. fruits and vegetables rich diet vs. DASH combination diet	BP, lipids, blood calcitriol and PTH, 10-y CHD risk, serum urate	No overall significant effects of diet × ethnicity on BP (67), calcitriol, PTH (72), or serum urate (74) Black (vs. White): Greater CHD risk reduction with DASH diet (71) Black men on DASH diet (vs. control): greater reductions in calcitriol (72)[8] Black (vs. White) on DASH diet (vs. control): Greater DEC in systolic BP (69, 68) Black (vs. White) on DASH diet (vs. control): Greater DEC in 24-hour SBP (73) Black (vs. non-Black) on DASH diet (vs. control): Similar DEC in TC, LDL-C and HDL-C (70)
Djuric et al. 2002 (75)	Randomized (4 groups)	12 wk	86 (32) (Original study: 113)	Black, White	Premenopausal women (age: 25–50 y, BMI: 22–34 kg/m^2)	Low energy (25% reduction in energy) vs. low fat (15% fat) vs. low-energy and low-fat vs. control (usual diet)	Weight, waist: hip ratio	No overall diet x race effects reported. Black (vs. White) on intervention diets: less weight loss but greater waist: hip ratio reduction[8]
The Trials of Hypertension Prevention Collaborative Research Group, 1997 (76)	Randomized (4 groups)	36 mo	2382 (494)	Black, White, Other	Overweight men and women with SBP <140 mmHg and DBP: 83-89 mm Hg (age: 30–54 y)	Intervention groups: weight loss, dietary sodium reduction and combined weight loss and dietary sodium reduction vs. control, i.e., usual care	BP	Black (vs. White): similar DEC in BP on intervention groups (vs. control)[8]
Chang et al. 2019 (77) McCann et al. 2021 (78)	Crossover (2 groups)	6 wk	252 (115) originally enrolled	African ancestry, European ancestry	Healthy postmenopausal women [age: 59.4 ± 6.2 (SD) y, BMI: 30.5 ± 7.6 (SD) kg/m^2]	Usual diet vs. flaxseed (10 g/d)	Urinary lignan metabolites	Black (vs. White): similar INC in enterolactone (78, 77), enterodiol and secoisolariciresinol (78) with flaxseed intervention[8]

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TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Ginsberg et al. 1998 (79) Kris-Etherton et al. 2020 (80)	Crossover (3 groups)	8 wk	103 (26)	Black, non-Black	Healthy men and women (age: 22–67 y, BMI: 17.3–32.1 kg/m^2)	Intervention groups: low saturated fat (26% fat, 5% SF), Step 1 (30% fat, 9% SF) vs. control, i.e., average American diet (AAD; 37% fat, 16% SF)	Lipid profile, Factor VIIc, fibrinogen, √PAI-1	Black (vs. non-Black): similar decrease in total-C, LDL-C (79),[8] VIIc and increase in fibrinogen and √PAI-1 (80) on intervention groups vs. AAD Black: No change in HDL-C and Apo A-I on Step 1 vs. AAD and TG on both intervention groups vs. AAD (79)[8]
Kahleova et al. 2021 (81)	Randomized (2 groups)	16 wk	244 (113)	Black, White	Overweight or obese men and women (age: 25–75 y, BMI: 28-40 kg/m^2)	Low-fat vegan diet (75% carbohydrates, 15% protein, 10% fat) vs. control group (no diet changes)	BMI, fat mass, lipid profile, glucoregulation	Black (vs. White): similar decrease in BMI, insulin resistance, fat mass, total-C, and LDL-C on vegan diet vs. control
Hispanic and non-Hispanic White adults								
Herron et al. 2002 (82)	Crossover (2 groups)	30 d	51 (22)	Hispanic, White	Premenopausal women (age: 18–49 y, mean BMI: 24 kg/m^2)	High dietary cholesterol diet (1 egg) vs. placebo diet	Cholesterol	Hispanic (vs. White): similar INC in LDL-C and HDL-C on high dietary cholesterol diet
Asian and White adults								
Garcia et al. 1991 (83)	Baseline period + crossover (2 groups)	28 d	20 (6)	Asian (Chinese), White[6]	Women (age: 19–35 y, BMI: 18–25 kg/m^2)	Baseline self-selected diets vs. US74 diet (40% fat, PUFA/Sat fat = 0.3) vs. MOD diet (30% fat, PUFA/Sat fat = 1.0)	Cholesterol	Asian: US74 diet (vs. MOD and self-selected diets): INC total-C and VLDL-C[8] White: MOD diet (vs. US74 and self-selected diets): DEC total-C, LDL-C and VLDL-C[8]

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TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Hsu et al. 2014 (84)	Randomized (2 groups)	16 wk total (8 wk control + 8 wk of either intervention or control)	50 (28)	Asian, White	Men and women (age: 25–55 y, BMI: 18.5–27 kg/m^2) at risk of developing type 2 diabetes	Traditional Asian diet (TAD, control) vs. typical Western diet (TWD, intervention)	Weight, insulin resistance	Asian (vs. White): smaller weight gain, and greater INC in insulin AUC and HOMA-IR on TWD (vs. TAD)[8]
Gronborg et al. 2019 (85) Gronborg et al. 2020 (86)	Randomized (2 groups)	12 wk	136 (70)	Asian (Pakistani), White (Danish)	Women (mean age: 35 y, mean BMI: 26 kg/m^2)	Vitamin D (20–30 μg/d) fortified foods (gouda, yogurt, eggs, whole-grain crisp bread) diet vs. nonfortified foods diet (control)	Vitamin D status, muscle strength, markers of bone turnover	Danish fortified group vs. Pakistani fortified group: greater INC in vitamin D intake and status (86) No changes in muscle strength or markers of bone turnover (85)
Pima Indian and White adults								
Swinburn et al. 1991 (87)	Crossover (2 groups)	14 d	24 (12)	Pima Indians, White	Nondiabetic men and women [age: 28 ± 5.6 (SD) y, BMI: 36 ± 13 (SD) kg/m^2]	Traditional Pima diet vs. high-fat modern diet	Plasma lipids, glucose tolerance	Pima Indian (vs. White) on high-fat modern diet (vs. traditional Pima diet): greater INC in total and LDL-C, and similar DEC in glucose tolerance[8]
Multiple races or ethnicities								
Juraschek et al. 2016 (88) Sacks et al. 2014 (89)	Crossover (4 groups)	5 wk	163 (97)	Non-Hispanic White, non-Hispanic Black, Hispanic, Asian	Overweight and obese men and women [age: 53 ± 11 (SD) y, BMI: 32 ± 6 (SD) kg/m^2]	High GI (GI ≥ 65) with high carbohydrate (58% kcal) vs. low GI (GI ≤ 45) with low carbohydrate (40% kcal) vs. low GI with high carbohydrate vs. high GI with low carbohydrate	Glycated albumin (GA), fructosamine, insulin sensitivity, lipid profile, BP	Non-Hispanic Black and White: similar reductions in GA and fructosamine with reduction in dietary carbohydrate (88)[8] Low GI, low-carbohydrate vs. high GI, high-carbohydrate: DEC in triglycerides but no effect on insulin sensitivity, systolic BP, LDL-C, or HDL-C. No race effect observed (89)[8]

(*Continued*)

TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Samaha et al. 2003 (90)	Randomized (2 groups)	6 mo	132 (82)	Black, Hispanic, White	Men and women with obesity (mean age: 54 y, mean BMI: 43 kg/m^2)	Low-carbohydrate vs. low-fat diet	Weight	Black (vs. White): smaller weight loss
Perry et al. 2004 (91) Hung et al. 2008 (92)	Randomized (2 groups)	7 wk + 7 wk	42 (28)	Black (14), Mexican American (MA, 14), White (14)	Women with methylenetetrahydrofolate reductase 677 CC genotype (age: 19–44 y, BMI: 19–32 kg/m^2)	Folate depletion: Baseline low-folate diet (135 μg DFE/d) for 7 wk Folate repletion: 400 or 800 μg DFE/d diet for next 7 wk	Blood folate, urinary folate, homocysteine, betaine, phosphatidylcholine	Black (vs. MA and White): lower blood folate and excretion of urinary folate throughout folate depletion and 400 and/or 800 μg DFE/d repletion (91)[8] MA (vs. Black and White): lower plasma total homocysteine throughout folate depletion and 400 μg DFE/d repletion (91)[8] MA and White: plasma phosphatidylcholine tended to INC during 800 μg DFE/d folate repletion (92) Significant but no clear week × diet × race effect for plasma betaine (92)

(*Continued*)

TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Hall et al. 2003 (93)	Original study randomized (2 groups)	6 mo	2208 (979)	Non-Hispanic White, Black, Hispanic	Postmenopausal women (mean age: 60 y, mean BMI: 29 kg/m^2)	Low-fat intervention (total fat < 20%) vs. control (no intervention)	Anthropometrics, glucose, insulin, BP, weight	Low-fat vs. control: greater DEC in systolic BP and BMI and a trend for greater DEC in glucose and insulin[8] White and Black on low-fat (vs. control): greater DEC in weight, waist and hips[8] Hispanic on low-fat (vs. control): similar DEC in weight, waist and hips[8]
Howard et al. 2010 (94)[7]	Randomized (2 groups)	8.1 y	2730 (1351)	White, Black, Hispanic, American Indian/Alaska Native, Asian/Pacific Islander	Postmenopausal women (age: 50–79 y, BMI: <18.5 to >40 kg/m^2)	Low-fat diet high in fruits, vegetables, and grains vs. usual diet control	Lipid profile	No effects of diet × race on triglyceride and HDL-C changes over year 1 Diabetic White (but not Black) on low-fat diet (vs. control): greater INC in triglyceride over year 1
Maskarinec et al. 2017 (42) BEAN 1 trial Maskarinec et al. 2009 (95)[7]	Randomized (2 groups)	2 y	220 (132)	White, Asian (Japanese, Filipino, Chinese), Native Hawaiian	Premenopausal women (mean age: 43 y, mean BMI: 26 kg/m^2)	High-soy diet i.e., 2 servings of soy foods daily [50 mg of isoflavones (aglycone equivalents)] vs. low-soy diet i.e., <3 soy food servings per wk	Biomarkers of breast cancer risk, breast density, CRP, IL-6, adiponectin leptin	Asian: DEC in IGF-1 on low-soy diet and INC on high-soy diet (42) Non-Asian: INC in IGF-1 on low-soy diet and high-soy diet (42) No effects of diet x ethnicity (Asian vs. non-Asian) for other breast cancer biomarkers, breast density, IL-6, CRP, adiponectin and leptin (42) Asian (vs. non-Asian) : INC in leptin on low-soy diet (95)[8]

(*Continued*)

TABLE 1 (*Continued*)

Author	Design	Intervention duration	Total participants (minority participants)[2]	Racial and ethnic groups[3]	Participant profile[4]	Dietary intervention	Main health outcome	Results by ethnicity/race × diet[5]
Maskarinec et al. 2011 (96) Maskarinec et al. 2017 (42) BEAN 2 trial	Crossover (2 groups)	6 mo	96 (48)	White, Asian (Japanese, Filipino, Chinese, Korean), Others (Native Hawaiian/Pacific Islander, Black, American Indian and other)	Premenopausal women (age: 39 ± 6 y, BMI: 26 ± 6 kg/m^2)	High-soy diet, i.e., 2 servings of soy foods daily vs. low-soy diet, i.e., <3 soy food servings per wk	Nipple aspirate fluid (NAF)	Asian (vs. White) (96)[8] and Asian (vs. non-Asian) (42): Similar effects (i.e., no change) on NAF volume in response to high-soy diet
Dodson et al. 1983 (97)	Randomized (2 groups)	1 mo	53 (34)	White, West Indian, Asian	Diabetic men and women with mild hypertension (mean age: 53 y)	High-fiber, low-fat and low-sodium dietary regime vs. control diet	BP, urinary sodium excretion	White and West Indian: similar DEC in DBP and urinary sodium excretion on intervention diet[8] Asian: no changes on intervention diet[8]
Miketinas et al. 2019 (98) Han et al. 2021 (99)	Randomized (4 groups)	6 mo	345 (44)	White, Black, Asian, Hispanic	Overweight and obese men and women [age: 53 ± 9 (SD) y, BMI: 33 ± 4 (SD) kg/m^2]	Low-fat, average-protein (20% fat, 15% protein) vs. low-fat, high-protein (20% fat, 25% protein) vs. high-fat, average-protein (40% fat, 15% protein) vs. high-fat, high-protein (40% fat, 25% protein)	Weight, insulin resistance, BP	Training model predicted a greater weight loss for White vs. non-White (98) MUFA intake was positively associated with weight loss for White (but not non-White) (98) No diet type × race effects retained or reported (98, 99)
Wolever et al. 2011 (100)	Randomized (5 groups)	4 wk	366 (70)	White, non-White	Men and women with LDL-C ≥3.0 and ≤5.0 mmol/L (age: 35–70 y, BMI: 18.5–40 kg/m^2)	Wheat bran cereal (control) vs. oat cereal with 3 g high-molecular weight (MW) or 4 g Medium-MW or 3 g Medium-MW or 4 g Low-MW oat β-glucan	LDL-C	White and non-White on oat β-glucan: similar reductions in LDL-C

[1]BP, blood pressure; CHD, coronary heart disease; CRP, C-reactive protein; DASH, Dietary Approaches to Stop Hypertension; DBP, diastolic blood pressure; DEC, decrease; DFE, dietary folate equivalents; HDL-C, HDL cholesterol; hs-CRP, high-sensivity C-reactive protein; hscTNI, high-sensitivity cardiac troponin I; GI, glycemic index; INC, increase; LDL-C, LDL cholesterol; MOD, modified; PAI-1, plasminogen activator inhibitor 1; PTH, parathyroid hormone; Sat, saturated; SBP, systolic blood pressure; SF, saturated fat; TAD, traditional Asian diet; total-C, total cholesterol; TWD, typical Western diet; US74, diet similar to US diet in 1974; VLDL-C, very low density cholesterol.
[2]In case of multiple publications from the same study, the total number of participants from the main or first publication are listed. Multiple publications from 1 study are grouped together.
[3]African American was changed to Black and Caucasian and European was changed to White for consistency purposes.
[4]Age and BMI ranges are presented. If range was not given, then either mean ± SD is presented, or overall mean was calculated from individual group means.
[5]Results indicating a change or difference are statistically significant. The term "subgroup analyses" indicates post hoc analyses conducted in the absence of statistically significant overall diet × race interaction effects, or when in the absence of a priori hypotheses, diet × race interaction effects were not included in the model or when included in model but effects/*P* values were not adequately described.
[6]One Iranian person not included in analysis.
[7]Subset of original study participants.
[8]Subgroup analyses conducted.

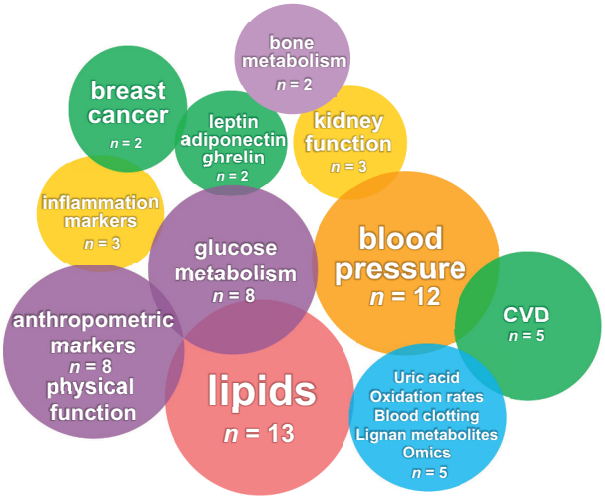

FIGURE 2 Health outcomes included in the systematic review examining the representation of ethnic and racial minorities in clinical nutrition interventions. Lipids were outcomes in 13 studies, including total lipids, cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, and APO-CIII lipoproteins; blood pressure was a main outcome in 12 studies; markers of glucose metabolism were outcomes in 8 studies, including blood glucose, glucose tolerance, insulin, insulin sensitivity, insulin resistance, glycated albumin, fructosamine, and B-cell responsiveness; anthropometric markers and physical function were outcomes in 8 studies, including body weight, fat mass, waist-to-hip ratio, and muscle strength; inflammation markers were the outcomes in 3 studies; markers of kidney function were outcomes in 3 studies; leptin, adiponectin, or ghrelin were outcomes in 2 studies; markers of CVD were outcomes in 5 studies; markers of breast cancer were main outcomes in 2 studies; bone metabolism indices such as vitamin D status, calcitriol, or bone turnover markers were outcomes in 2 studies; uric acid, macronutrient oxidation rates, blood clotting markers, lignan metabolites, or metabolomics profiles were outcomes in 5 studies. CVD, cardiovascular disease.

had similar increases in LDL and HDL cholesterol with a high dietary cholesterol diet (105). In the Women's Health Trial: Feasibility Study in Minority Populations, Black and White but not Hispanic adults showed a greater decrease in weight and waist and hip circumference with a low-fat diet compared with the control (93). A study in Pima Indians found a greater increase in plasma lipids compared with White adults in response to a high-fat diet. Interestingly, both groups achieved better glucose-related metabolic indicators when consuming a traditional Pima diet compared with a high-fat diet (87).

A few studies examined responses to dietary interventions in multiple ethnic or racial groups. For example, a high-fiber, low-fat, and low-sodium diet resulted in similar decreases in diastolic BP and urinary sodium excretion in West Indian and White adults, but no changes were observed for these outcomes in Asians (97). Another study that grouped all non-White adults together observed similar reductions in LDL cholesterol with oat cereal with B-glucan consumption in both White and non-White adults (100).

Very few studies discussed tailoring the diet to the ethnic or racial group under consideration. In studies by Maskarinec et al. (42, 95, 96) soy foods consumed were selected based on the similarity with traditional Asian foods. In studies by Gronborg et al. (85, 86), only vitamin D–fortified foods that were commonly consumed by both Danish and Pakistani people were chosen.

Risk of bias and quality of assessment of studies included in systematic review

Characteristics of the included studies are summarized in **Table 2**. According to the Oxford Centre for Evidence-Based Medicine level of evidence (43), 44 study articles were classified as 1b, indicating high-quality individual randomized controlled trials (RCTs), and 14 were classified as 2b, which denotes RCTs with less than 80% participant completion or inclusion in analyses. According to the Academy of Nutrition and Dietetics Quality Criteria Checklist for Primary Research risk-of-bias assessment (44), 43 articles were rated positive, indicating that they had adequately addressed issues of bias, generalizability, and data collection and analysis. The remaining 15 were found to be neutral, meaning they were neither exceptionally weak nor exceptionally strong. Twenty-six articles reported and described diet by race interaction analyses (Table 2). Other studies either did not report or include overall diet by race interaction effects in the statistical model, restricted their analysis to only selected diet arms without specifying a priori hypotheses, or adjusted for race or ethnicity in the statistical model but failed to adequately explain how the dietary intervention effects were stratified by race (Table 2).

Pertinent studies not included in systematic review

Acute studies.

Eight studies that accounted for race or ethnicity in their analyses were acute trials (105–113). Five studies assessed the glycemic responses to specific foods (including drinks) (105–108, 110), 1 examined the effects of a high-fat compared with a low-fat meal on cardiovascular outcomes (111), 1 examined the effects of a high-glycemic- compared with a low-glycemic-load meal on appetitive hormones (112, 113), and 1 study examined the effects of circulating natriuretic peptides in response to a high-carbohydrate challenge (109). The characteristics and findings of these studies are shown in Supplemental Table 2.

Studies limited to 1 diet arm.

Ten studies that accounted for race and/or ethnicity in their analyses examined pre-post effects of a dietary intervention (114–124), including low-fat, high-fiber, fruit-and-vegetables diets; energy-restricted diets; high-fat, high-calorie diets; alternate-day fasting; or dietary phytate restriction. The characteristics and findings of these studies are shown in Supplemental Table 3. Notably, one of those studies found skeletal muscle mass loss during diet-induced weight loss among European-American compared with African-American women (120). Another study found differential metabolic adaptations to energy restriction, characterized

TABLE 2 Risk-of-bias analysis of studies included in the systematic review examining the representation of ethnic and racial minorities in clinical nutrition interventions[1]

Study	Selection of participants free from bias	Study with >80% follow-up[2]	Standard/ valid/reliable data collection procedures	QCC rating[3]	Evidence grade[4]	Statistical analyses sufficiently described/appropriate for overall diet × race effect interpretation over time[5]
Parallel-arm studies						
Maskarinec et al. 2017 (42), BEAN 1 trial	Yes	Yes	Yes	✚	1b	Yes
Maskarinec et al. 2009 (95)	Yes	Yes	Yes	✚	1b	No
Appel et al. 2001 (66)	Yes	No	Yes	✚	2b	No
Howard et al. 2010 (94)	Yes	No	Yes	✚	2b	Yes
Ellis et al. 2012 (59)	Yes	Yes	Yes	Ø	1b	Yes
Goree et al. 2011 (58)	Yes	Yes	Yes	Ø	1b	Yes
Perry et al. 2004 (91)	Yes	Yes	Yes	✚	1b	No
Hung et al. 2008 (92)	Yes	Yes	Yes	✚	1b	Yes
Miketinas et al. 2019 (98)	Yes	Unclear	Yes	Ø	2b	No
Han et al. 2021 (99)	Yes	Unclear	Yes	Ø	2b	No
Hsu et al. 2014 (84)	Yes	Yes	Yes	Ø	1b	No
Bales et al. 2017 (60)	Yes	No	Yes	Ø	2b	No
Erlinger et al. 2002 (55)	Yes	Yes	Yes	✚	1b	No
Conlin et al. 2003 (56)	Yes	Yes	Yes	✚	1b	No
Prather et al. 2011 (57)	Yes	Yes	Yes	✚	1b	Yes
Dodson et al. 1983 (97)	Yes	Yes	Yes	Ø	1b	No
Hall et al. 2003 (93)	Yes	No	Yes	✚	2b	No
Samaha et al. 2003 (90)	Yes	No	Yes	✚	2b	No
Vollmer et al. 2001 (61)	Yes	Yes	Yes	Ø	1b	Yes
Bray et al. 2004 (62)	Yes	Yes	Yes	Ø	1b	No
Turban et al. 2013 (63)	Yes	Yes	Yes	Ø	1b	Yes
Derkach et al. 2017 (64)	Yes	No	Yes	Ø	2b	No
Murtaugh et al. 2018 (65)	Yes	Yes	Yes	Ø	1b	Yes
Appel et al. 1997 (67)	Yes	Yes	Yes	✚	1b	Yes
Hassoon et al. 2018 (72)	Yes	No	Yes	✚	2b	Yes
Chen et al. 2010 (71)	Yes	Yes	Yes	✚	1b	Yes
Svetkey et al. 1999 (68)	Yes	Yes	Yes	✚	1b	Yes
Sacks et al. 1999 (69)	Yes	Yes	Yes	✚	1b	No
Tyson et al. 2018 (73)	Yes	No	Yes	✚	2b	Yes
Obarzanek et al. 2001 (70)	Yes	Yes	Yes	✚	1b	Yes
Juraschek et al. 2021 (74)	Yes	No	Yes	✚	2b	Yes
The Trials of Hypertension Prevention Collaborative Research Group, 1997 (76)	Yes	Yes	Yes	✚	1b	No
Djuric et al. 2002 (75)	Yes	No	Yes	✚	2b	No
Wolever et al. 2011 (100)	Yes	Yes	Yes	✚	1b	Yes
Kahleova et al. 2021 (81)	Yes	Yes	Yes	Ø	1b	No
Gronborg et al. 2019 (85)	Yes	Yes	Yes	✚	1b	Yes
Gronborg et al. 2020 (86)	Yes	Yes	Yes	✚	1b	Yes

(*Continued*)

TABLE 2 (*Continued*)

Study	Selection of participants free from bias	Study with >80% follow-up[2]	Standard/ valid/reliable data collection procedures	QCC rating[3]	Evidence grade[4]	Statistical analyses sufficiently described/appropriate for overall diet × race effect interpretation over time[5]
Crossover studies						
Branis et al. 2015 (45)	Yes	Yes	Yes	✚	1b	Yes
Berk et al. 2006 (46)	Yes	Yes	Yes	✚	1b	Yes
Swinburn et al. 1991 (87)	Yes	Yes	Yes	Ø	1b	No
King et al. 2007 (47)	Yes	Yes	Yes	✚	1b	No
Gerhard et al. 2000 (48)	Yes	Yes	Yes	✚	1b	Yes
Garcia et al. 1991 (83)	Unclear	Yes	Yes	Ø	1b	No
Herron et al. 2002 (105)	Yes	Yes	Yes	✚	1b	Yes
Wright et al. 2003 (49)	Yes	Yes	Yes	✚	1b	No
Appel et al. 2005 (50)	Yes	Yes	Yes	✚	1b	No
Furtado et al. 2010 (51)	Yes	Yes	Yes	✚	1b	No
Kovell et al. 2020 (52)	Yes	Yes	Yes	✚	1b	No
Howard et al. 1995a (53)	Yes	Yes	Yes	✚	1b	No
Howard et al. 1995b (54)	Yes	Yes	Yes	✚	1b	Yes
Maskarinec et al. 2011 (96)	Yes	Yes	Yes	✚	1b	No
Maskarinec et al. 2017 (42), BEAN 2 trial	Yes	Yes	Yes	✚	1b	Yes
Juraschek et al. 2016 (88)	Yes	Yes	Yes	✚	1b	No
Sacks et al. 2014 (89)	Yes	Yes	Yes	✚	1b	No
Chang et al. 2019 (77)	Yes	No	Yes	✚	2b	No
McCann et al. 2021 (78)	Yes	No	Yes	✚	2b	No
Ginsberg et al. 1998 (79)	Yes	Yes	Yes	✚	1b	No
Kris-Etherton et al. 2020 (80)	Yes	Yes	Yes	✚	1b	Yes

[1] QCC, Quality Criteria Checklist.
[2] Follow-up here takes into account participant attrition or participants included in analysis.
[3] QCC rating (44): ✚, report has clearly addressed issues of inclusion/exclusion, bias, generalizability, and data collection and analysis; Ø, report is neither exceptionally strong nor exceptionally weak.
[4] Oxford Centre for Evidence-Based Medicine Levels of Evidence (43).
[5] The statistical analyses rating is independent of and not accounted for in the QCC rating. Studies rated as "No" either did not report or include overall diet by race interaction effects in the statistical model, restricted their analysis to only selected diet arms without specifying a priori hypotheses, or adjusted for race or ethnicity in the statistical model but failed to adequately explain how the dietary intervention effects were stratified by race.

by improved glucose disposal rate and decreased shift from glucose to lipid oxidation, among South Asian men compared with European men (115).

Studies with a single ethnic or racial minority group.
Twenty-five studies focused on only 1 ethnic or racial group (125–151). Seven of these studies included only Black adults, 5 studies included Hispanics or adults of Mexican origin, 12 studies were in adults of Asian origin, and 1 was in Native American adults. The diversity of the dietary interventions ranged from whole diet interventions (e.g., DASH, healthy food choices) to specific foods (e.g., rice, karela). The characteristics and findings of these studies are shown in Supplemental Table 4.

Among studies focused on Black adults, an 8-wk DASH-dinner intervention reduced BP in low-income hypertensive African-American adults (141). A high-dairy diet followed for 24 wk decreased adiposity, insulin, and BP independently of weight loss compared with a low-dairy diet in African-American men and women with obesity (149). Among studies that recruited Hispanic adults, a traditional Mexican diet compared with a common US diet followed for 24 d improved insulin sensitivity in healthy women of Mexican descent (142). In another study (143), Caribbean Hispanics—predominantly Dominicans and Puerto Ricans—who were major allele carriers of the LIPC locus had lower HDL cholesterol following a 4-wk traditional diet compared with a Western diet. Among studies that recruited Asian adults, improvement in metabolic risk factors was observed when shifting from white rice to brown rice for 3 mo in a prediabetic Chinese-American population (147). Moreover, consuming a Mediterranean diet in the context of intermittent energy restriction for 12 wk improved indices of liver function more than the DASH diet among East Asians in Hawaii (139). Another study found a moderately low-carbohydrate, energy-restricted diet decreased insulin resistance and reduced cardiovascular disease risk factors in overweight, insulin-resistant Indian women (127). Last, a single study in Native American women with hypercholesterolemia found that a flaxseed intervention resulted in reduced total and LDL cholesterol (140).

Other studies.
Three studies were crossover studies of sodium dietary restriction (1 dietary intervention) but with sodium or placebo supplementation (152–156) (Supplemental Table 5) and did not fit in the other study categories. Overall, the studies that stratified outcomes by race or ethnicity (154, 155) did not detect an effect of race on reductions in BP with sodium restriction.

Discussion

Summary of evidence

This systematic review revealed the scarcity of peer-reviewed articles on clinical nutrition interventions that have study designs robust enough to advance the knowledge on improving nutrition-related health outcomes in racial or ethnic minorities. This stands in striking contrast to the disproportionate burden of diseases experienced by ethnic and racial minority groups and is in line with what others have reported in the area of behavioral weight loss (5). Most studies that met the inclusion criteria compared Black with White adults, with other ethnic and racial groups being vastly underrepresented. Most dietary interventions involved energy restriction, macronutrient modification, variations of the DASH diet, and reductions in sodium intake. Future research is needed to expand the variety of health outcomes and types of dietary interventions to improve the health of racial and ethnic minorities. Exploring the relevance of dietary interventions to specific minority groups within and beyond the parameters of current diet approaches is also warranted.

Evidence from the studies reviewed (60, 75, 90) aligns with existing literature (157, 158) that indicates that Black adults, particularly women, respond less favorably to weight-loss interventions. Possible explanations are lower energy requirements (157), higher baseline weight (75) and fat-free mass (159), and preservation of skeletal muscle mass during weight loss (120). Despite smaller weight loss, greater improvements in waist-hip ratio (75) are observed and a decrease in adiposity is also seen independently of weight loss in Black adults (149). Many of the studies reviewed failed to report whether the diet treatment was tailored for acceptability by all the groups studied. Lack of consideration for group-specific eating patterns, cultural preferences, and lifestyle factors in the design of the diet treatment sharply limits the ability to make mechanistic explanations and adherence comparisons, thus obscuring the value and sustainability of the intervention outside the research context (160–163). Intervention studies must be designed for cultural relevance and control for social, economic, and environmental factors that may inform intake. Future studies must explore the effectiveness of culturally sensitive interventions and their value at mitigating racial and ethnic disparities in nutritional outcomes.

The high prevalence of high BP among Black adults has motivated the development of several dietary interventions, the most popular being the DASH diet and its reduced-sodium version. The DASH approach is a diet rich in fruits, vegetables, and low-fat dairy products with reduced saturated and total fat. Overall, evidence indicates that Black adults achieve greater reductions in BP with the DASH diet compared with White adults. Proposed explanations for BP differences are mostly biological, hence incomplete, and include differences in salt sensitivity, body mass, and baseline potassium intake (63, 164. More research is needed to further characterize the factors contributing to these differences, including examining the aptness of existing instrumentation to accurately measure outcomes in minority populations (165, 166) and determining the extent to which contextual (12) rather than biological factors mediate these

differences, and their potential relevance to other diet-related outcomes and interventions. For instance, evidence is accumulating on the role of experiences of discrimination in the chronic activation of the stress response and its direct impact on cardiometabolic health (167). In addition, stigma and perceived discrimination have been associated with diminished food access and worse diet quality (28, 168, 169).

Strengths and limitations of the review

This review is unique in that it profiles the representation of racial and ethnic minority groups in clinical nutrition interventions conducted in regions where non-Hispanic Whites are the majority population group. A strength of the systematic review is the large volume of literature considered in the initial search and the diversity of outcomes screened. However, both the heterogeneity of dietary interventions and outcomes and the limited number within each class limited the ability to make direct comparisons among studies. To minimize this limitation, studies that deployed lifestyle interventions where the dietary intervention was not explicitly defined were excluded. An added strength of this review is that studies with 1 diet arm, acute studies, and studies focusing on a single ethnic or racial group are reported separately to provide a more comprehensive review of the available evidence.

Most studies examined the differential effects of dietary interventions by race or ethnicity in subgroup analyses that ignored diet by race interaction effects. There is a need for adequately powered studies for accurate interpretation of race by diet effects over the intervention. Moreover, differences in outcomes by race and ethnicity cannot be suitably studied with insufficient sample sizes for population subgroups. Factors that help explain variability in responses and those that can offer mechanistic insight, such as 'omics techniques for biological factors, and socioecological context, should be included and adequately powered (158). Other limitations of the studies included in the review are limited information on the ancestry or geographic origin of the groups studied, narrow scope of nutrition interventions, insufficient discussion of diet acceptability, and limited consideration of the impact of sociocultural factors on health outcomes.

Implications of findings and future directions

A scant proportion of the clinical nutrition research conducted with ethnic and racial groups is robust enough to confidently identify interventions to reduce health disparities and explore their underlying mechanisms. Most of the few studies with quality designs have been conducted with Black and African American groups to study dietary interventions to improve cardiometabolic and weight-related outcomes. With emerging precision nutrition initiatives that aim to optimize metabolic responses in adults or population subgroups through tailored dietary approaches, it is imperative to ensure adequate representation of racial and ethnic subgroups for understanding and appropriately addressing nutrition-related health disparities. Noteworthy strategies for the recruitment and retainment of historically underrepresented groups used by behavioral and community-based studies may be also useful to clinical nutrition research. Some of these strategies include community engagement for establishing trusting academic–community relationships, diversifying research workforce, training staff in cultural competencies, and peer-to-peer sampling strategies (5, 170).

In addition, moving beyond the traditional attribution to genetics and biological factors, key questions remain on the socioecological mechanisms and contextual factors that contribute to explain intervention success or failure. As reviewed previously (171), factors driving dietary behavior of racial and ethnic minorities can be clustered into 7 main contexts: migration (e.g., region of origin, urban vs. rural, westernization), sociocultural environment (e.g., identity, beliefs, traditions, acculturation, social networks), food perceptions (e.g., familiarity, preferences, cost), food accessibility (e.g., availability, price, convenience), health- and body-related perceptions and behaviors (e.g., body image, dieting), psychosocial (e.g., taste preferences, attitudes, norms, self-efficacy), and social and material resources (e.g., income, education, language proficiency). Characterizing such factors in the context of clinical nutrition research is paramount to establishing internal and external validity in research and feasibility in practice. Hence, future intervention studies must include measures of these and other determinants of nutritional health to better demonstrate the value of the findings. Future directions for addressing key gaps in nutrition research examining ethnic and racial disparities in health outcomes are highlighted in a 4-step framework in **Table 3**.

Conclusions

The gap in clinical nutrition research with ethnic and racial minorities is large—thus, the possibilities are vast. The parallel nutrition disparities affecting these groups underscore the urgency of closing this gap. Reverting these disparities also requires scrutinizing paradigms that consider practices of White groups the norm and ideal. It also demands challenging the assumption that findings from White groups can be applied to groups with different cultural and contextual backgrounds without ethical repercussions, including upholding the principle of justice (172). An intentional and joint commitment from all sectors involved in the clinical nutrition research enterprise—from conception and funding to implementation and dissemination—is required to achieve sufficient representation of ethnic and racial groups in clinical nutrition research and cogently alleviate the nutrition disparities affecting them.

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TABLE 3 Future direction framework for addressing key gaps in clinical nutrition research examining ethnic or racial disparities in health outcomes

1) Conduct exploratory studies (cohort, case-control, cross-sectional) to expand the understanding of the dietary patterns of ethnic and racial minorities and their association with health outcomes, with emphasis on subgroup differences.
2) Design dietary interventions that reflect the eating patterns of ethnic and racial minorities and test their feasibility and acceptability among those groups and subgroups.
3) Test the efficacy of culturally sensitive dietary interventions at improving relevant health outcomes in robust clinical studies, paying strong consideration to contextual variables known to mediate eating behavior in the groups of interest.
4) Compare and contrast the adoption, maintenance, and effectiveness of dietary interventions on health outcomes between different ethnic and racial minorities to build evidence on approaches to mitigate diet-related health disparities.

all authors: read and approved the final manuscript and take responsibility for the final content.

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