Special Article

Relationship between living alone and food and nutrient intake

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The increase in the number of individuals living alone has implications for nutrition and health outcomes. The aim of this review was to investigate whether there is a difference in food and nutrient intake between adults living alone and those living with others. Eight electronic databases were searched, using terms related to living alone, nutrition, food, and socioeconomic factors. Forty-one papers met the inclusion criteria, and data of interest were extracted. Results varied but suggested that, compared with persons who do not live alone, persons who live alone have a lower diversity of food intake, a lower consumption of some core foods groups (fruits, vegetables, and fish), and a higher likelihood of having an unhealthy dietary pattern. Associations between living alone and nutrient intake were unclear. Men living alone were more often observed to be at greater risk of undesirable intakes than women. The findings of this review suggest that living alone could negatively affect some aspects of food intake and contribute to the relationship between living alone and poor health outcomes, although associations could vary among socioeconomic groups. Further research is required to help to elucidate these findings.

INTRODUCTION

The number of individuals living alone across the developed world continues to increase and is considered an important demographic and social change.[1,2] In 2010, the percentage of 1-person households ranged from 23% to 29% in Australia, Canada, the United Kingdom, and the United States, from 30% to 49% in Western Europe, and 31% in Japan.[2] This sociodemographic change is of relevance to health organizations, health policymakers, and healthcare professionals, such as dietitians, as nutrition behaviors are likely to be directly influenced by living arrangements. In addition, nutrition behaviors are also likely to be influenced by financial, social, lifestyle, and environmental factors,[3] which themselves are also linked to the likelihood of living alone.[1,2] The complex social interaction among living arrangements, food, nutrition, and dietary behaviors and their impact on long-term health and well-being is unclear. While evidence is not consistent,[4] research has identified relationships between living alone and a higher risk of adverse health outcomes, including diabetes,[5] mortality, cardiovascular death,[4] falls, functional impairment, and social isolation.[6] Nutrition intake and nutritional status are two of numerous possible interacting factors that explain the difference in health outcomes.

A review investigating the nutritional circumstances of older people living alone concluded that, compared with their cohabiting peers, they are economically disadvantaged and face a greater struggle in daily living.[7] A review of psychosocial changes associated with reduced food intake in older persons identified living alone, widowhood, and social isolation as important factors influencing psychosocial wellbeing.[8] However, as far as can be determined, the influence of living alone on multiple food and nutrition behaviors across a range of ages and genders has not been previously explored. As demographic data shows that persons living alone are a large, growing, and diverse group,[1] it is important to question stereotypes and assumptions around the

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types of people who live alone[2] and the influence living alone has on food and nutrition. The available data highlight some important gender differences, with men living alone more likely to be younger and socially disadvantaged.[1,2] Some tendencies, however, are apparent across both genders, such as a trend for persons living alone to be from the highest and lowest socioeconomic groups.[1,2] This review aimed to explore quantitative evidence from observational studies comparing food and nutrient intake between noninstitutionalized adults living alone and those living with others in order to investigate the implications of living alone in the development and treatment of nutritional problems. The null hypothesis for this review is that there is no difference in food and/or nutrient intake between persons who live alone and those in other living arrangements.

METHODS

Published guidelines for selecting studies and collecting data for systematic reviews were followed where possible.[9] In addition, as no previous review on this specific topic was identified, any eligible published research was considered to be of interest. The review therefore attempts to balance the strengths of both systematic and narrative reviews.[10] The presence of heterogeneity was anticipated in study designs, methods, participants, outcomes reported, and the cohabiting groups compared with the target population. Associations between living alone and nutrition-related behaviors were expected to be a component, rather than the primary focus, of many of the studies identified.

Literature search

Papers were identified by searching 8 databases – CINAHL (Cumulative Index to Nursing and Allied Health Literature)/EBSCO host, Embase, Scopus, PsycINFO, Proquest Health and Medical Complete, PubMed, Web of Science SSCI, and Web of Science SCI Expanded – between 1990 and September 2, 2014. The first author performed the database search. Search terms were identified by exploring MeSH subject terms. The following search terms were used, with asterisks denoting truncation: living alone, living arrangements, loneliness, social isolation, one-person household, single person, marital stat*, singleness*, divorce, widowhood, social class, socioeconomic stat, socioeconomic position and nutr*, food or diet*. To identify as many studies as possible, a broad search strategy was employed but was restricted to English-language publications only. All articles were exported into an Endnote version X6 library and duplicates removed. The reference lists of articles that met eligibility criteria were also reviewed.

Inclusion and exclusion criteria

Predetermined eligibility criteria guided the study selection. Inclusion criteria included English language, published after 1990, quantitative research, and presentation of original research. Articles were excluded if they related only to marital status, solitude, isolation, or loneliness or if the study population consisted of animals, pregnant women, infants, children, adolescents, groups with disease (e.g., cardiovascular disease or cancer), or hospitalized or institutionalized individuals. Studies designed to investigate the association between foods or nutrition and disease outcomes were also excluded. Articles were also excluded if they were conducted in locations where demographic data on living arrangement were not available or where proportions living alone are below 10% (such as Africa, South America, China, or South Korea). Articles were included in the review if the abstract, title, or keywords indicated the study investigated food or nutrient intake in people living alone compared with people living with others. Cross-sectional, case–control, or cohort studies were eligible for inclusion. Articles published only as abstracts from conference proceedings were excluded.

Recording and synthesis of research findings

The following data were recorded for each study: first author, year, and nationality; sample characteristics, including population, recruitment, sample size, gender, age of participants, and the percentage living alone; research design; living arrangement groups examined; nutrition or food behaviors; and a summary of the significant associations that were identified (Table 1). Detailed information is available in Appendix S1 in the Supporting Information for this article that is available online. This information was recorded by the author and was cross-checked to identify any errors.

Study quality was appraised independently by both authors using the criteria presented in Table 1, with any disagreements discussed. Criteria were derived from the National Institutes of Health for Observational, Cohort and Cross-Sectional Studies.[11] The following criteria were identified as relevant to the studies included: response or participation rates, study design (cross-sectional/retrospective or cohort/prospective), use of a validated method of dietary assessment, assessment of food portions, primary focus of the paper on living arrangements, nationwide study, random selection of participants, and use of multivariate analyses to investigate

Table 1 **Study quality in relation to criteria**[a]

Reference	Sample (n)	Response rate (%)	Cross-sectional/ retrospective	Prospective or cohort	Validated dietary assessment	Food portions assessed	Primary focus on living arrangements	Multivariate analysis	Nationwide study	Randomly selected
Individuals										
Bae et al. (2007)[41]	6331	NS	Y	N	NS	Y	Y	Y	N	Y
Ball et al. (2003)[48]	10 561	82	Y	N	Y	Y	N	Y	Y	Y
Barberger-Gateau et al. (2005)[26]	9280	40[b]	Y	N	NS	N	N	Y	Y	Y
Davis et al. (1990)[28]	4402	NS	Y	N	Y	Y	Y	N	Y	Y
Davis et al. (2000)[27]	6525	NS	Y	N	Y	Y	Y	Y	Y	Y
Dean (2009)[53]	3200	N	Y	N	NS	N	N	Y	N	N
Donkin et al. (1998)[44]	369	67	Y	N	Y	Y	Y	Y[c]	N	N
Dynesen et al. (2003)[46]	995	62	Y	N	Y	N	N	Y	Y	Y
Friel et al. (2003)[30]	6539	62	Y	N	Y	Y	N	Y	Y	Y
Friel et al. (2005)[31]	5979	62	Y	N	Y	N	N	Y	Y	Y
Gerrior et al. (1995)[32]	5841	NS	Y	N	Y	Y	Y	N	Y	Y
Gillman et al. (2001)[55]	1322	60	Y	N	Y	Y	N	Y	N	Y
Hart et al. (2006)[57]	2507	68	Y	N	Y	N	N	Y	N	Y
Holmes et al. (2011)[56]	662	55	Y	N	Y	Y	N	Y	Y	Y
Hunter et al. (2010)[33]	473	50	Y	N	Y	Y	Y	Y	N	Y
Irz et al. (2014)[34,d]	9587	NS	Y	N	Y	N	N	Y	Y	Y
Itoh et al. (1995)[50]	190	NS	Y	N	Y	Y	N	Y	N	N
Kesse-Guyot et al. (2009)[60]	5194	88[b]	Y	N	Y	Y	N	Y	Y	N
Kharicha et al. (2007)[6]	2601	60	Y	N	NS	N	Y	Y	N	N
Larrieu et al. (2004)[35]	9250	40[b]	Y	N	NS	N	N	Y	N	Y
Maynard et al. (2006)[38]	1647	52	Y	N	Y	N	N	Y	Y	N
Murphy et al. (1993)[36]	2627	NS	N	Y	Y	Y	Y	Y	Y	Y
Pearson et al. (1998)[52]	1909	34–81	Y	N	Y	Y	Y	N	N	Y
Prevost et al. (1997)[63]	Study 1: 9003	73.5	N	Y	NS	N	N	Y	Y	Y
	Study 2: 5090	NS								
Pryer et al. (2001)[64]	1097	59	Y	N	Y	Y	N	N	Y	Y
Rogers & Pryer (2012)[49]	2197	70	Y	N	Y	Y	N	Y	Y	Y
	1724[e]	47								
Sharkey et al. (2010)[47]	582	17	Y	N	Y	Y	N	Y	N	N
Shelton (2005)[39]	7319	76	Y	N	NS	NS	N	Y	Y	Y
Small et al. (1994)[51]	34	NS	Y	N	Y	Y	N	N	N	N
Touvier et al. (2010)[23]	4574	88[b]	Y	N	Y	Y	N	Y	Y	N
Touvier et al. (2010)[25]	4574	88[b]	Y	N	Y	Y	N	Y	Y	N
Touvier et al. (2011)[24]	4574	88[b]	Y	N	Y	Y	N	Y	Y	N
Villegas et al. (2004)[59]	851	70	Y	N	Y	N	N	N	N	Y
Wakita Asano et al. (2009)[45]	4261	NS	Y	N	Y	Y	N	Y	Y	Y
Walthouwer et al. (2014)[62]	379	51	N	Y	Y	Y	N	Y	Y	N
Whichelow et al. (1996)[58]	9003	78	Y	N	NS	N	N	Y	Y	Y
Williams et al. (2010)[37]	355	44	Y	N	Y	Y	N	Y	N	Y
Zipp & Holcomb (1992)[40]	100	NS	Y	N	Y	Y	Y	Y	N	N

(continued)

Table 1 **Continued**

Reference	Sample (n)	Response rate (%)	Cross-sectional/ retrospective	Prospective or cohort	Validated dietary assessment	Food portions assessed	Primary focus on living arrangements	Multivariate analysis	Nationwide study	Randomly selected
Households										
Deeming (2011)[29]	5600	60	Y	N	Y	Y	N	Y	Y	Y
Irz et al. (2014)[34,d]	7743	NS	Y	N	Y	Y	N	Y	Y	Y
Naska et al. (2006)[61]	94 564	NS	Y	N	Y	N	N	Y	Y	Y
Temple (2006)[54]	1898	NS	Y	N	Y	N	N	Y	Y	Y

Abbreviations: N, no; NS, not specified; Y, yes.
[a]Criteria derived from the National Institutes of Health for Observational, Cohort, and Cross-sectional Studies.[11]
[b]Participation rate.
[c]Adjusted for sex and age only.
[d]Data from Finland and Italy are from households. Data from the UK and Sweden are from individuals.
[e]Study conducted using two cohorts in 1986–1987 and 2000–2001.

possible confounding factors. Earlier references were obtained to confirm missing aspects of study design, wherever possible.[12–19]

RESULTS

Figure 1 summarizes the study selection process.[20,21] A total of 830 studies were identified as potentially eligible after the titles were screened. Of these, 283 were excluded after review of the abstract because the study did not fulfill the inclusion criteria, resulting in a full-text review of 547 manuscripts. Eleven of these were potentially relevant articles identified by hand searching the reference lists of all included articles. Ten did not meet eligibility criteria, and 1, a government report, represented grey literature.[22] Forty-one of these articles met all of the inclusion criteria. Some of the papers included were derived from the same parent study; however, with the exception of 3 studies,[23–25] each paper was based upon a different subset of participants.[26–37] Nine of the studies focused on investigating food and nutrient intake across different living arrangements, whereas the remaining 32 studies included living arrangements as one of multiple social factors.

Quality of studies included

Study characteristics relevant to quality are summarized in Table 1. Further information on study populations is also available in Appendix S1 in the Supporting Information online. Thirty-eight of the 41 papers that met the selection criteria were based upon cross-sectional data, and 3 featured cohort designs. Twenty-four studies included some multivariate statistical analyses, although living alone was not included in 4 studies that did not show bivariate relationships.[37–40] One study conducted separate multivariate analyses in the living alone and cohabiting groups,[41] and 1 did not include living alone in a classification tree analysis, although bivariate associations were shown.[31]

Thirty-three of the 41 studies included over 500 participants, 29 of which had more than 1000 participants. While the studies contained large samples, they were predominantly explorative and so did not include power calculations to predict the ability of the study to detect differences. Generalizability of results is also influenced by recruitment methods, and this is also a strength of the research in this area, with 26 studies including participants from large nationwide studies. In addition, 28 studies recruited participants randomly. Response or participation rates were included where relevant and available, ranging from 17% to 88%, with 24 of the 28 studies that included rates reporting 50% or greater.

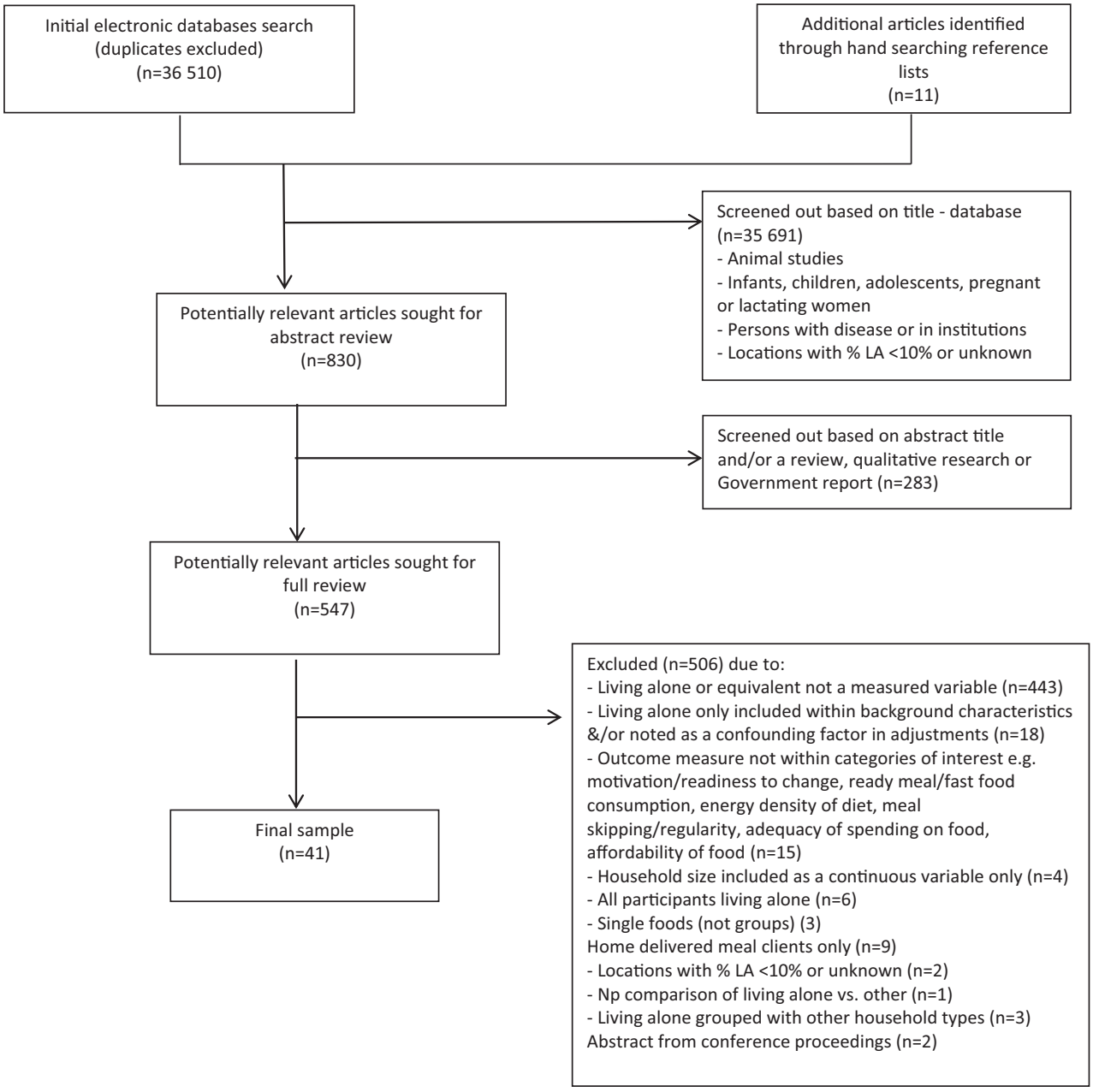

Figure 1 **Flow chart summary of the search strategy.** Diagram based upon Carbone and Zoellner (2012)[20] and Moher et al. (2009).[21]
Abbreviation: LA, living alone.

Interpretation of results is complicated by the variety of methodologies used to assess food and nutrient intake. Each method has strengths and limitations,[42,43] but 33 of the 41 studies used a method of dietary assessment that has been validated (Table 1). Table 2 identifies they key methods used to assess food and nutrient intake. Eight studies did not indicate whether the tools used had been validated.

Study results

The outcomes measured by each study have been grouped as follows: food group intake; nutrient intake; a summary score of food and/or nutrient intake; and food-based analysis of dietary patterns (Table 2). Studies that included more than one category are grouped separately. All associations and differences described are significant at the level of $P < 0.05$ or below.

Food group intake. Eighteen studies investigated associations between living alone and intake of one or more food groups as either absolute intake or compliance with food-based recommendations. Fourteen studies investigated fruit and/or vegetable intake, with 10 finding that men and/or women living alone had a lower fruit

Table 2 **Summary of food and nutrient intakes in persons living alone compared with persons not living alone**[a]

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Studies investigating intake of food groups				
Donkin et al. (1998)[44] UK	n = 369 38.8% living alone; 48% M; ≥65 y	Living alone Married	FFQ: frequency of consumption of FV	MV analysis: FV consumption in M living alone: 2.66 (0.33) portions per day compared with 4.1 (0.22) portions overall. Living status and gender significant for fruit consumption $F(3, 210) = 5.66$, $P < 0.001$; vegetable consumption $F(3, 210) = 6.14$, $P < 0.001$
Larrieu et al. (2004)[35] France	n = 9250 35.8% living alone; 39.3% M; ≥65 y	Living alone Living with a spouse or co-tenant	FFQ: frequency of consumption of 9 food groups	BV analysis[d]: higher proportion of people living with others than living alone reported regular consumption of food groups in M (fish, eggs, cereals, raw vegetables, cooked fruits and vegetables, pulses) and F (meat, fish, eggs, cereals, raw fruits, raw vegetables, cooked fruits and vegetables, pulses). Patterns confirmed in MV analysis. Results not presented
Barberger-Gateau et al. (2005)[26] France	n = 9280 37.8% living alone; 39% M; ≥65 y	Living alone Living with a spouse/ partner Living with others	FFQ: frequency of consumption of fish (including seafood)	MV analysis: persons living with a spouse/partner more likely to consume fish at least weekly compared with those living alone (OR [95%CI]: 1.86 [1.61–2.16])
Friel et al. (2005)[31] Ireland	n = 5979 13.8% living alone; 45.8% M; ≥18 y	Living alone Living with others	FFQ: percentage consuming recommended number of servings from food groups: CBP, FV, dairy (dairy and alternatives), MFP, and top (foods high in sugars and fats)	BV analysis: M living alone less likely than those living with others to consume recommended number of servings of CBP and FV. M living alone more likely than those living with others to consume the recommended number of servings of dairy. M and F living alone more likely to consume recommended servings of MFP, foods high in sugars and fats. MV analysis: living alone not included
Bae et al. (2007)[41] United States	n = 6331 19.8% living alone; 39.2% M; ≥18 y	Single-member household Multiple-member household	Questionnaire, yes or no for: Consumption of ≥5 servings of FV per day Consumption of foods high in fat 7 days per week	BV analysis: those living alone less likely to consume foods high in fat than those in multiple-member households in F only (17.9% vs 31.5%). MV analysis: analyzed separately for single and multimember households
Kharicha et al. (2007)[6] UK	n = 2601 33.1% living alone; 45.6%M; ≥65 y	Living alone Living with others	Questionnaire, yes or no for: Consumption of >2 high-fat food items per day	MV analysis: those living alone more likely than those living with others to have low fruit and fiber in diet (OR [95%CI]: 1.42 [1.2–1.7])
Wakita Asano et al. (2009)[45] Japan	n = 4261 7.6% living alone; 40.9% M; 20–69 y	Living alone 2-person household 3-person household ≥4-person household	1-d weighed food record: vegetable intake in grams per day	MV analysis: lower vegetable consumption in M living alone for all age groups. Compared with lowest consumption in those with other living arrangements, vegetable consumption in those living alone was 27% lower in 20–39 y, 24% lower in 40–59 y and 18% lower in 60–69 y in M only. Adjusted for age only. Living alone not included in other MV analysis models
Hunter et al (2010)[33] Australia	n = 473 11% living alone; 100% F; 43–72 y	Living alone Living with others	FFQ for fruit intake, high (≥2 servings per day) vs low (<2 servings per day); and for vegetable intake, high (≥3 servings per day) vs low (<3 servings per day)	MV analysis: living alone associated with lower consumption of fruits (regression coefficient c = 1.87, $P < 0.05$) and vegetables (c = 1.096, $P < 0.05$)

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Sharkey et al. (2010)[47] United States	n = 582 27.7% living alone; 31.8% M; 60–90 y	Living alone Living with others	2-item screener: FV intake (separate and combined)	MV analysis[d]: All analyses for living alone compared with living with others. Negative associations between living alone and vegetable intake or combined FV intake (for all models). Associations modeled for network distance from participant residence to nearest supermarket, food store with a good selection of fresh fruits, or vegetable or food store with a good selection of fresh and processed fruits or vegetables
Touvier et al. (2010)[25] France	n = 4574 13.8% living alone; 54.7% M; 45–60 y	Living alone Living with others	6 × 24-h dietary records: 1) adherence to starchy food recommendation; and 2) variety and type of starchy foods consumed	MV analysis: no significant results
Touvier et al. (2010)[23] France	n = 4574 13.8% living alone; 54.7% M; 45–60 y	Living alone Living with others	6 × 24-h dietary records: variety and type of meat/seafood/eggs consumed	MV analysis: number of different meat/seafood/eggs consumed lower in those living alone than in those cohabiting (adjusted mean ± SE: 4.57 ± 0.04 vs 4.66 ± 0.02)
Williams (2010)[37] Australia	n = 355 77.5% living alone; 100% F; 18–65 y	Living alone Not living alone	FFQ: FV intake	BV analysis: no significant associations between living arrangements and likelihood of high FV consumption. MV analysis: living alone not included
Rogers (2012)[49] UK	n = 2197 (1986–1987) and 1724 (2000–2001) 7.1% living alone (1986–1987); 20.6% living alone (2000–2001); 49.9% M (1986–1987); 58.5% M (2000–2001); 16–64 y (1986–1987); 19–64 y (2000–2001)	Living alone Living with spouse/partner, no children Living with other adults, no spouse/partner, no children Living with children and spouse/partner Living with children, no spouse/partner	7-d weighed food record: compliance with FV recommendations	MV analysis: no significant results
Studies investigating intake of nutrients				
Zipp et al. (1992)[40] United States	n = 100 54% living alone; 100% F; ≥65 y	Living alone Living with a spouse	FFQ: intake and percentage of RDA for energy, protein, and selected micronutrients per day	BV analysis: no significant results. MV analysis: living alone not included
Small et al. (1994)[51] Canada	n = 33 66.7% living alone; 100% F; 65–83 y	Living alone Living with others	1 × 24-h recall: intake of energy and selected macro- and micronutrients per day	BV analysis: no statistically significant differences in energy or nutrient intakes by living arrangement
Itoh et al. (1995)[50] Japan	n = 190 5.8% living alone; 45.8% M; 65–80 y	Living alone Living with a spouse Living with others	3-d food record: intake of iron, thiamine, riboflavin, and ascorbic acid per 1000 kcal	MV analysis: no significant results

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Pearson et al. (1998)[52] 8 European countries	n = 1909 27% living alone; 49.9% M; 70–75 y	Living alone Living with spouse/ partner Living with others	3-d food record + food checklist: intake of energy, macronutrients, and micronutrients per day	BV analysis[d]: M living alone: intake lower than in those living with spouse/partner for protein; intake higher than in those living with spouse/partner for cholesterol, vitamin A; intake lower than in those living with others for vitamin C; higher than in those living with others for saturated fat, cholesterol, riboflavin, calcium. F living alone: intake lower than in those living with spouse/partner for nil nutrients; intake higher than in those living with spouse/ partner for riboflavin, calcium; intake lower than in those living with others for energy, protein, carbohydrate; intake higher than in those living with others for vitamin A, riboflavin, calcium
Friel et al. (2003)[30] Ireland	n = 6539 M, 14.6% living alone; F, 13% living alone; 46.6% M; ≥18 y	Living alone Living with others	FFQ: intake of energy, macronutrients, and micronutrients per day	BV analysis[d]: in M living alone, intake lower than in those living with others for energy, protein, cholesterol, fiber, vitamin C, vitamin D, folate, thiamin, iron, selenium, zinc. In F living alone, intake lower than in those living with others for cholesterol, vitamin B_{12}, selenium, zinc. MV analysis: lower percent energy from fat in those living alone (β [*t*-value] −0.062 [−2.04]). Higher percent energy from carbohydrate in those living alone (0.047 [1.52]). Micronutrients not included
Studies calculating a summary score based on food intake				
Murphy et al. (1993)[36] US	n = 2627 Change from living with spouse to living alone: M: 7.9%, F: 21% Living alone at both time points: M: 5.7%, F 24.1% 49.1% M; 45–74 y at baseline	Lived with spouse at baseline, living alone at FU Living with spouse at baseline and at FU Living alone at both time points	FFQ: food groups and food quality (average of the percentage of recommended servings of 4 food groups: dairy, protein foods, FV, grains)	MV analysis: M living alone at both time points compared with those living with spouse at both time points consumed a lower percentage of recommended FV (difference [95%CI] −9.8% [−16.9 to −2.8]). F living alone at both time points compared with those living with spouse at both time points consumed a lower percentage of recommended protein foods (−5.2% [−8.4 to −1.9]). Food quality negatively related to years living alone. Regression coefficients: M, −0.23 ($P = 0.04$); F, −0.5 ($P = 0.44$)
Gillman et al (2001)[55] US	n = 1322 15.6% living alone; 31.5% M; ≥25 y	Living alone Not living alone	FFQ: food groups categorized as most (0 points), less (1 point), and least desirable (2 points). Scores >1.3 classified as "failed" for the group. More healthful: ≤1 failed domain; suboptimal: ≥2 failed domains	MV analysis: NS difference in percentage of those living alone within suboptimal vs more healthful domains
Temple (2006)[54] Australia	n = 1898 households 1-person households: 38.3% (26.7% F; 11.5% M); overall percent M and F not reported; ≥55 y (head of household)	Couple only Lone female Lone male Couple with children Living with others	Diary recording of weekly household expenditure on 110 food items: dietary variety score	MV analysis: M and F living alone purchased ≈40% and ≈25% fewer food items, respectively, than couple households (IRR [95%CI] 0.597 [0.564–0.631] for M; 0.752 [0.719–0.786] for F). Couples with children and those living with others had a higher dietary variety score (IRR [95%CI] 1.127 [1.07–1.186] for C + Ch; 1.127 [1.045–1.216] for living with others)

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Dean et al. (2009)[53] 8 European countries	n = 3200 (n = 400 per country) 48–52% living alone; 48–52% M; ≥65 y	Living alone Living with partner	Consumption of food groups. Food group scored once if portion ≥2 tablespoons. Food variety score: >15/wk = adequate; >30/wk = excellent	MV analysis: significant independent effects for living arrangement ($\beta = -0.08$, $P < 0.001$), suggesting that those living with a partner eat a more varied diet than those who live alone. NS when resources and goals included
Studies calculating a summary score based on nutrient intakes				
Davis et al. (1990)[28] United States	n = 4402 28.6% living alone; 42.3% M; ≥55 y	Living alone Living with spouse	1 × 24-h recall + 2-d written diet record: dietary quality. Low quality = intake <60% of RDA for selected micronutrients. Poor quality = low intake for ≥5 micronutrients	MV analysis: no significant results
Gerrior et al. (1995)[32] United States	n = 5841 12.5% living alone; 45% M; ≥19 y	Single-person household Multiple-person household	1 × 24-h recall + 2-d written food record. Adequacy expressed as percentage of RDA for protein and selected micronutrients (score/100). Moderation expressed as percent energy from fat, saturated fat, cholesterol, and sodium (score/100). Higher scores indicate better compliance	BV analysis: dietary adequacy index lower in those living alone than in multiperson households for F 19–34 y (26.4 ± 3.6 vs 38.2 ± 1.4) and M 35–54 y (39.1 ± 6.2 vs 53.0 ± 1.6). Dietary moderation index higher in those living alone than in multiperson households for F of all ages (46.6 ± 1.9 vs 39.1 ± 0.9), F 19–34 y (44.9 ± 3.4 vs 36.7 ± 1.3), M of all ages (32.0 ± 3.2 vs 21.8 ± 1.0), and M 19–34 y (32.1 ± 4.6 vs 21.2 ± 1.4). Dietary moderation index higher in those living alone than in multiperson households for income, urbanization, white or nonwhite, overweight or normal weight, region, and supplement use
Davis et al. (2000)[27] United States	n = 6525 22.9% living alone; 47.4% M; ≥50 y	Living alone Living with spouse only Living with spouse plus others Living with person other than spouse	1 × 24-h recall: diet quality score (no. of low nutrients of a possible 15, with low defined as <67% of the RDA)	MV analysis: no significant results
Hart et al. (2006)[57] United States	n = 2507 22.5% living alone; 14% M; ≥18 y	Living alone Living with spouse/partner Living with other	Fat- and fiber-related behavior questionnaire: fat score derived from questionnaire (lower score indicates lower fat intake)	MV analysis: living alone did not make a significant contribution to the model
Deeming (2011)[29] UK	n = 5600 households 3069 single persons and 2556 couples (M and F) Overall percent M and F not specified; ≥60 y	Single woman Single man Couple	2-wk food diary, household consumption: 1) intake of energy and selected nutrients; and 2) food nutrition security based on meeting ≥70% of minimum dietary standards	MV analysis: those living alone less likely than couples to meet ≥70% of minimum dietary standards for energy (OR 0.72), food, and nutrition (OR 0.69) in M only
Studies calculating a summary score based on food and nutrient intakes				
Maynard et al. (2006)[38] UK	n = 1234 17.4% living alone; 54.5% M; 61–80 y	Household size: 1, 2, ≥ 3	FFQ: Healthy Diet Score. Score based on intake of saturated and polyunsaturated fats, protein, carbohydrate, fiber, fruits, vegetables, pulses, nuts, sugars, cholesterol, fish, red meat, and calcium	BV analysis: NS difference in Healthy Diet Score by number of people in household MV analysis: living alone not included in MV analysis

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Shelton et al. (2005)[39] Scotland	n = 7319 Percent living alone not reported; 50% M; 16–74 y	Living alone Living with others	Food frequency interview: healthy eating score. Score based on tertiles for selected dietary targets (saturated fat, sugar, salt, fruits, vegetables, starches, oily fish, fiber). Total scores dichotomized into unhealthy/healthy eating	BV analysis: no significant differences between groups for healthy eating score. MV analysis: living alone not included
Holmes et al. (2011)[56] UK	n = 725 73% living alone; 32.3% M; ≥65 y	Living alone Not living alone	4 × 24-h recall: Diet Quality Index	BV analysis: NS association between Diet Quality Index and living alone. MV analysis: living alone included as a confounding factor, but results not shown
Studies investigating intake of food groups and nutrients				
Ball et al. (2004)[48] Australia	n = 10 561 9% living alone; 100% F; 50–55 y	Living alone Living with partner only Living with children only Living with partner and children Living with others	FFQ: compliance with dietary guidelines for food groups and nutrients	MV analysis: no significant results
Touvier et al. (2011)[24] France	n = 4574 13.8% living alone; 54.7% M; 45–60 y	Living alone Living with others	6 × 24-h dietary records: 1) adherence to dairy recommendation; 2) variety and type of dairy foods consumed; 3) dietary calcium intake and adequacy	MV analysis: those living alone more likely than those living with others to have inadequate calcium intakes (OR [95%CI] 0.7 [0.6–0.9])
Studies calculating summary scores based on food groups, food, and/or nutrients				
Irz et al. (2014)[34] 4 European countries	Finland: n = 2994 households Italy: n = 7564 individuals Sweden: n = 2023 individuals UK: n = 4749 households Percent living alone not reported; percent M and F not specified; ≥50 y	Male alone Female alone Couple ≥3 households excluded	Finland: 2-wk food diary plus receipts Italy: FFQ Sweden: semiquantitative FFQ UK: 2-wk diary of all food and drink purchases 1) (UK, Sweden, Finland) 2) Recommendation Compliance Index (Italy)	MV analysis[d]: M living alone, compared with couples ($\beta \pm$ SE), had a lower intake of FV in Italy (-0.366 ± 0.047) and Finland (0.110 ± 0.042). Mixed results for intake of nutrients across countries and sex. M living alone and F living alone, compared with couples ($\beta \pm$ SE) had a lower DQI in the UK (-1.772 ± 0.649 in M and -1.443 ± 0.507 in F) and Finland (-2.040 ± 0.832 in M and -1.390 ± 0.622 in F) and a trend for a lower Recommended Compliance Index in Italy (-0.025 ± 0.004 in M and -0.009 ± 0.003 in F, $P < 0.1$). Living alone not a significant determinant of diet quality in Sweden
Dynesen et al (2003)[46] Denmark	n = 995 24.7% living alone; 48.2% M; 15–90 y	Single-person household Multiple-person household, excluding children Multiple-person household, including children	FFQ: 1) Adherence to food-based dietary guidelines; 2) HDI score (0–15) based on adherence to guidelines (0 no adherence)	MV[d]: Multiperson households including and excluding children more likely to adhere to guidelines for fruit and fish as a main meal. Multiperson households including children more likely to adhere to guidelines for fish with sandwiches. Multiperson households, including and excluding children, more likely than those living alone to have an HDI score in the top vs the lowest quintile. For M: (2.54 [1.07–6.05]) for households including children, (6.06 [2.33–15.77]) for households excluding children. For F: (2.15 [1.01–4.58]) for households including children, (3.60 [1.41–9.17]) for households excluding children

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Studies investigating food-based dietary patterns or clusters				
Whichelow et al. (1996)[58] UK	n = 9003 12% living alone; 43.1% M; ≥18 y	Household size: 1, 2, 3, 4, 5, ≥6	FFQ: 4 dietary patterns: 1) Frequent fruits, salads, vegetables, infrequent high-fat food; 2) frequent high-starch foods, most vegetables and meat; 3) frequent high-fat foods; 4) sweets, biscuits, and cakes, with low vegetable intake	MV analysis: component 1 most popular with F but not M living alone ($P < 0.001$); component 2 increased in popularity with increasing household size, with those living alone unlikely to follow this pattern ($P < 0.001$); component 4 most favored by those living alone ($P < 0.001$)
Prevost et al. (1997)[63] UK	n = 5090 for baseline and follow-up 9.0% living alone (baseline); 14.2% living alone (follow-up); 43% M; ≥18 y	Living with family at baseline and follow-up Living alone at baseline and follow-up Living alone at baseline, living with family at follow-up Living with family at baseline, living alone at follow-up	FFQ: dietary component scores [emsp]1) frequent fruits, salads, brown bread, fruit juice, vegetables, low fat spread, and milk; 2) frequent dessert, potatoes, cream, meat, pulses, confectionery, preserves, eggs, and light desserts; 3) frequent crisps, soft drinks, fried food, coffee, pasta, rice, and processed meat; 4) frequent confectionery biscuits and cake	MV analysis: no significant association between household size and dietary component scores at baseline or FU. Change in dietary component scores from baseline to FU not significant
Pryer et al. (2001)[64] UK	n = 1097 35.4% living alone; 49% M; ≥65 y	Living alone Not living alone	4-d weighed food record Identification of clusters: mixed; healthy; and traditional	BV analysis: no significant difference in the proportion living alone within each dietary pattern
Villegas et al. (2004)[59] Ireland	n = 851 13.6% living alone; 49.1% M; 50–69 y	Living alone	FFQ: 3 dietary patterns: 1) traditional diet; 2) prudent diet; 3) alcohol and convenience foods	BV analysis: a higher percentage of those living alone were represented within the alcohol and convenience foods cluster (25.8%) compared with prudent diet (12.8%) and traditional diet (13.4%). Cluster 3 97% M
Naska et al 2006[61] 10 European Countries	94 564 households Percent living alone gender, and age not reported	Adult household (1 member) Adult household (2 members) Adult + children (lone parent) Adults + children Elderly household (1 member) Elderly household (2 members)	Goods and services available to household members. Principle components: wide range of foods including fruits, vegetables, cereals, meat, fish, and dairy; beverage and convenience food buyers	MV analysis[d]: Mediterranean and Scandinavian populations: adults living alone more likely to have lower scores in PC1. Central/northern European populations: elderly living alone more likely to have lower PC2 scores
Kesse-Guyot et al (2009)[60] France	n = 5194 F, 17.5% living alone; M, 9.6% living alone; 52.6% M; 45–60 y	Living alone Not living alone	Repeat 24-h diet records (≥6 over 2 y): 4 dietary patterns [emsp]1) alcohol and meat; 2) prudent diet; 3) convenience foods; 4) starch, sauces, and vegetables	MV analysis: living alone positively associated with higher intake of convenience foods among M (OR [95%CI]=1.33 [1.01–1.75]

(continued)

Table 2 **Continued**

Reference, country	Number, percent living alone, gender, age	Explanatory variables	Outcome variable	Results[b,c]
Walthouwer et al (2014)[62] the Nether lands	n = 483 at baseline, 379 at follow-up 17.2% living alone; 53.8% M; 18–65 y	Living alone Not living alone	FFQ: 3 dietary clusters. Healthy cluster; moderately healthy cluster; unhealthy cluster	MV analysis: people who lived alone more likely than people who lived with others to be in the group that shifted toward an unhealthier cluster compared with stable group (OR [95%CI] = 3.48 [1.01–11.99], $P = 0.05$)

Abbreviations: BV, bivariate; C + Ch, couples with children; CBP, cereals, breads, potatoes; CI, confidence interval; DQI, Diet Quality Index; F, female; *F*, F ratio; FFQ, food frequency questionnaire; FU, follow-up; FV, fruits and vegetables; HDI, Healthy Diet Index; IRR, incidence rate ratio; M, male; MFP, meat, fish, and poultry; MV, multivariate; NS, nonsignificant; RDA, Recommended Dietary Allowance; SE, standard error.
[a]All studies were of cross-sectional design except Murphy et al.,[36] Prevost et al.,[63] and Walthouwer et al.[62]
[b]Only significant results are presented.
[c]Only bivariate results are presented if no further multivariate analyses were conducted.
[d]Results too extensive to present all data. See Appendix S1 in the Supporting Information online for further information.

and/or vegetable intake or were less likely to comply with recommendations than people cohabiting. This relationship was seen in men, but not women, in 5 of the studies.[31,34,36,44,45] Two studies that analyzed men and women separately found lower intakes of fruits but not vegetables[46] or of fruits and vegetables[35] in those living alone. A study of women only found lower fruit and vegetable intake in those living alone.[33] Two studies that analyzed men and women together found lower intakes of fruits[6] or of fruits and vegetables[47] in those living alone. Of the 4 studies that found no associations, 2 included only female participants.[37,48] A third was based on a single question with unspecified validity.[41] The fourth, however, included men and women, and intake was assessed by 7-day food records,[49] whereas most other studies used questionnaires.

Seven studies investigated the frequency of consumption of meat, fish, and poultry or the compliance with dietary recommendations for these foods. Of those that investigated fish or seafood separately, all 3 found that men and women living alone were less likely to consume fish.[26,35,46] Results for consumption of meat, fish, poultry, and eggs are less clear. One found that men and women living alone were more likely to consume meat as a main meal[46] or to consume recommended amounts of meat, fish, and poultry.[31] However, another found that women, but not men, were less likely to report regular meat consumption.[35] Murphy et al.[36] found that women living alone at 2 time points were less likely than those with a spouse at both time points or with a spouse at baseline only to consume the recommended servings of meat and alternatives. Another study found that men and women living alone had a less varied intake of meat, seafood, and eggs.[23]

No clear pattern was evident for intake of grains and/or potatoes or intake of milk and milk products. Two studies found that consumption of cereals or compliance with recommendations was lower in men and women[35] or in women only.[31] However, 2 studies found no association with adherence to recommendations for starchy foods[25] or with consumption of grain foods.[36] Regarding milk and milk products, 1 study found that men but not women aged 18 years and over were more likely to consume recommended amounts of dairy,[31] whereas 2 found no association with adherence to recommendations in men or women between 45 and 74 years of age.[24,36] Of the studies that included intake of grains and/or dairy, only Friel[31] included adults below the age of 45, which could limit generalizability to younger adults.

Four studies investigated living alone and consumption of foods high in fat and/or sugar, with conflicting results. Of the 2 that examined compliance with recommendations, 1 found that men and women living

alone were more likely to comply with recommendations for intake of foods high in fat and sugar,[31] although the other, which included women only, found no association.[48] However, both studies that reported a difference performed bivariate analyses only, and Ball et al.[48] also found similar results in bivariate analysis. Consistent with these findings are those that women, but not men, who live alone are less likely to consume foods high in fat at the bivariate level.[41] A second study, however, found no association in multivariate analysis between living alone and the likelihood of consuming high-fat foods in men or women.[6] In all the studies that looked at intake of food groups, the influence of age is not clear because studies did not specifically investigate this, and a mix of age groups was included in studies that did and did not report results.

Nutrient intake. All studies estimated nutrient intake from foods only with nutrient intake from supplements not assessed. Six studies investigated macronutrient and/or micronutrient intakes per day. Three of these found no differences in intakes between persons living alone and those living in other arrangements,[40,50,51] but they were all small studies with 33 to 190 participants. Three larger studies did find multiple differences in daily energy, macronutrient, and micronutrient intakes. Two reported no clear patterns, with intakes of some nutrients being higher in persons living alone and intakes of other nutrients being lower.[34,52] The third found that intakes that differed were all lower in persons living alone, with living alone appearing to have a greater influence on micronutrient intake in men than in women.[30] Two of these studies only looked at the difference in absolute intakes at a bivariate level.[51,52] Friel[30] did complete multivariate analyses to investigate the independent association with proportion of energy from macronutrients, finding a negative association in persons living alone for fat and a positive association for carbohydrate. Five of these 6 studies included persons over 50 years of age, and 2 included only female participants, which could influence generalizability of results.

Two studies did investigate compliance with recommendations for specific nutrients. One of these, which included women aged 50–55 years, found no differences at the multivariate level.[48] Another study reporting only on calcium intakes found that women living alone had a higher prevalence of inadequate intake, but this was not assessed at the multivariate level.[24]

Summary scores based on food and/or nutrient intakes. Six studies investigated living alone compared with other arrangements and summary scores based upon intakes of food. Although the methods used to calculate the scores varied, they were based primarily upon assessing quality in terms of variety of intake and/or compliance with food-based recommendations. Four of these studies found that living alone was negatively associated with dietary quality in individuals[36,46,53] or households,[54] whereas 2 studies found no association.[55,56] Of the studies that found no association, one was comparatively smaller and only included low-income participants.[56] While the second was larger and included men and women aged 25 years and over, the validity of the scoring system used to classify diets as more or less healthful was not clear.[55] Of the studies that did find an association, 2 specified that the scoring system used was validated,[53,54] whereas 2 did not.[36,46] Any association with age is not clear, as studies that did and did not find associations included participants with a mix of ages.

Four studies calculated a summary score based upon the percentage of nutrient recommendations met, tallied across multiple individual nutrients in men and women.[27–29,32] One study also calculated a moderation index based upon energy from fat, saturated fat, cholesterol, and sodium.[32] With respect to adequacy of nutrient intake, 2 studies found that individuals living alone[32] or 1-person households[29] had diets of lower adequacy, although the first of these investigated bivariate associations only. The 2 that found no associations had participants aged 50 years and above, whereas the studies that found associations had participants over 19 years of age[32] or with household heads aged 60 years and above.[29] The single study that looked at moderation found that compliance with standards was higher in men and women living alone.[32] While multivariate analysis was not conducted, the authors observed this across a range of sociodemographic variables. However, a fifth study that examined only fat intake behaviors found no difference between groups in multivariate analysis.[57]

Three studies calculated a summary score based upon a combination of foods and nutrients. The validity of the score was discussed for 2 studies, but not for the third study.[39] Two studies found no association between the summary score and living arrangements in men and women aged 61–80 years[38] and 16–74 years.[39] The third study calculated results using data from 4 different national studies of adults over 50 years of age. Negative associations were found for males and females living alone compared with couples for the scores used in Finland, Italy, and the United Kingdom, although no association was seen in Sweden.[34] Data for Finland and the United Kingdom were studied at the household level.

Food patterns. Seven studies used cluster or principle component analysis to classify different dietary patterns.

The number of specific clusters/components chosen ranged from 2 to 4. While comparison is complicated by the variation in studies, some patterns are apparent. Three studies found an increase in popularity of unhealthy dietary patterns among persons living alone for men and women over 18 years of age[58]; for men and women 50 to 69 years of age, although the cluster was mainly male[59]; and for men – but not women – 45 to 60 years of age.[60] One study found that single-adult households in Mediterranean and Scandinavian populations were less likely to purchase foods characteristic of a healthier pattern of eating.[61] A fifth study with a longitudinal design further found that, among men and women aged 18–65 years, those living alone were more likely to shift to a less healthy diet between baseline and follow-up.[62] In contrast, 1 of these studies found that women, but not men, were more likely to consume a diet high in fruits and vegetables and low in fatty foods,[58] and another found that elderly 1-person households in central or northern Europe were less likely than other types of households to purchase beverage or convenience foods. Two of the 7 studies found no associations with dietary cluster/component scores.[63,64] Again, a mix of age ranges was seen across all the studies. All but 1 of the studies[59] used a nationwide sample, 2 studies had fewer than 1000 participants,[59,62] and 1 study analyzed results only at the bivariate level.[64]

The relationship between study findings and socioeconomic factors that could be related to living alone is difficult to establish. In only 2 studies were all participants of low-income/socioeconomic position, with 1 finding an association in an entirely female group[37] and 1 finding no associations.[56] Of the studies that investigated the relationship between living arrangements and food or nutrient intake using multivariate analyses, only 3 did not specifically consider at least 1 indicator of socioeconomic position, such as income, education, or occupation,[40,44,47] suggesting that results are likely to be independent of these factors. A fourth study was restricted to low-income participants,[56] and a fifth did not specify the variables adjusted for in the analysis. Marital status was included in multivariate analyses in only 7 studies,[23–25,30,34,49,55] and location (region or rural vs urban) was included in 13,[23–25,29,30,34,48–50,58,60,61,63] including 3 based upon the same participants,[23–25] which provides limited evidence on the interactions between living alone and marital status or location.

DISCUSSION

This review is believed to be the first to investigate the relationship between living alone and food and nutrient intake. Significant differences were reported in 32 of the 41 eligible studies identified, although 6 of these found that the results did not remain significant at the multivariate level of analysis. There was heterogeneity in results, which could be due to variation in the studies included but could also reflect the diversity of persons who live alone. Despite these complexities, some patterns were suggested. Studies that looked more broadly at dietary patterns or clusters found that persons living alone were less likely to follow healthy diets, although this was not consistent, with some studies suggesting that women and/or older age groups living alone were more likely to follow a healthier diet. The studies that used summary scores based on food intake indicated that dietary variety was lower in persons living alone, although again this was not seen in all studies. Results from summary scores that included nutrients were less consistent. For the studies that focused on food groups, the most consistent evidence is available for lower intake of fruits, vegetables, and fish in persons living alone. Although 1 of the studies that found no relationship with vegetable intake used a 7-day food record, which is least susceptible to recall bias, most of the studies that did find a link used validated tools. Fish intake was consistently seen to be lower in people living alone, but findings on meat intake were not consistent. Few conclusions about nutrient intake can be drawn, with studies reporting variable results.

Of the 9 studies that reported no significant results, 2 were small studies of 33 and 190 persons.[50,51] One included only low-income participants,[56] 2 did not specify if dietary assessment methods were validated,[39,63] and 1 was not a nationwide study.[55] Another was 1 of 3 papers reporting on the same study participants,[25] with the other 2 showing some significant associations.[23,24] If only the study results at the multivariate level are considered, no conclusions on study quality or results can be drawn, as larger national studies that used validated tools were seen across the studies that did and did not report significant findings. However, significant associations were seen in all 4 studies conducted at the household level. Interaction with socioeconomic factors such as age, education, income, rural/urban location, and marital status is also difficult to interpret, particularly since most studies were not designed to investigate the association between living alone and diet but included living arrangements as one of multiple socioeconomic factors. A combination of different potential confounding factors was adjusted for in studies that did and did not find significant results. Discussion of this topic must therefore consider the complex context within which these socioeconomic and dietary factors interact.

Socioeconomic factors and living alone. A combination of interrelated changes has resulted in an increase in

persons living alone. Discussion of the changes that have contributed to the rise in living alone are discussed elsewhere.[1,2] Briefly, these include the following: changes in the population age structure, including disparity in life expectancy between men and women and age difference between partners; encouragement of youth independence; delay in partnering and having children; increases in childlessness; decline in family size; likelihood of women having custody of children after divorce; higher rates of couple dissolution; "living apart together" arrangements; and demise of the multigenerational family household.[1,2]

Given the range of factors that have influenced the increase in people living alone, it is not surprising that research shows this population to be a diverse and changing group in which nutrition and health needs and risks are likely to vary. This is consistent with this review's findings of variation in the food and nutrient intakes of participants living alone compared with those in other living arrangements. Elements of demographic change that should be given particular prominence when considering the links between living alone and nutrition include diversity in gender, socioeconomic position, and age.[1,2] Certain demographic characteristics can influence the likelihood of living alone, which could have implications for food and nutrition behaviors and outcomes. Further, there are many aspects of living alone that could influence food and nutrition practices. The diverse characteristics of people living alone and the complex social and demographic changes thought to underlie the rise in 1-person households could shape the influence of living alone on food and nutrition in ways that both enable and hinder compliance with recommendations to optimize nutrition status. This could partly explain why, although most studies found living alone to be linked to undesirable food intake, some studies found a greater number of healthy behaviors in some groups of persons living alone, while others found no differences.

Living alone could represent a barrier to healthy eating that is related to the cultural and social roles of food and cooking. Jamieson and Simpson[2] commented that "how people reflect on and manage eating in the context of living alone is a specific focus that . . . sheds light on processes of social integration, given that eating with others is a universal means of sustaining and celebrating relationships." Multiple studies have highlighted a reduction in motivation and enjoyment in cooking and/or eating when alone, often manifested as the preparation of simple meals or the use of ready-made meals.[2,65–69] Other potential consequences are the absence of support or encouragement to comply with healthy eating guidelines[66] and difficulty in managing portion control.[2] Study findings of less diversity in food intake, lower consumption of fruits and vegetables, and a higher likelihood of consuming an unhealthy food pattern are consistent with these observations.

A lack of cooking skills can also contribute to the difficulty of preparing meals when alone, a particular risk in bereaved or divorced persons previously reliant on their partner for food preparation.[69] In some circumstances, the problem may be an inability to adapt to cooking for only 1 person.[2,70] Lack of assistance in purchasing or acquiring food can also increase the burden of preparing meals, a particular problem if challenges with lifting and transporting food exist.[67,69,70] The higher presence of barriers to obtaining and preparing meals in persons living alone is supported by findings from 4 studies investigating living arrangements and the use of supplemental food programs such as Meals on Wheels. All 4 studies found that persons living alone were more likely than other groups to use these services.[71–74] Challenges in acquiring and preparing food could also contribute to the reduced diversity of foods consumed by persons living alone.

Increases in cost of living, cost of food per head, and cost of energy associated with living alone could also influence eating practices, as persons living alone are less able to take advantage of economies of scale due to issues such as spoilage, taste fatigue, and storage constraints.[2,32,54] An increased likelihood of food insecurity or reduced food access in persons living alone compared with persons living in other arrangements has been reported in 5 studies[75–79] and supports the suggestion that food cost is a problem for many people who live alone. Demographic data suggest that the groups living alone most likely to be affected by economic factors are men and elderly women who have lower incomes than persons of the same age living with others.[1,2] Economic factors could explain lower consumption of foods such as fish, fruits, and vegetables, which require more frequent purchase and consumption and can also be more expensive.

Psychological and mental health factors associated with living alone could also influence food intake. The correlations among living alone, isolation, and loneliness are complex.[80] Having a large social network does not necessarily indicate the absence of loneliness,[80] and living alone is not synonymous with being alone or loneliness.[80,81] The link with isolation is possibly stronger; while not all persons who live alone are isolated, most who are isolated live alone,[80] and research indicates that the risk of both loneliness and social isolation is higher in persons living alone.[6,81,82] Evidence suggests that psychological factors can affect people differently, resulting in increased or decreased dietary intake. For example, in a review of social and emotional origins of comfort eating, Grant[83] discussed that, with reference

to loneliness, eating provides a sense of comfort that replaces human connections that persons long for but do not have. Research has also found that loneliness is a significant predictor of malnutrition in the elderly.[84] Living alone also entails an absence of social constraints around what constitutes a proper meal.[85] The impact of the presence of others when eating also should be considered. A review of the effect of the presence of others highlighted that social influences on eating are profound[86] and discussed evidence from different research areas indicating that it can result in either increased or decreased intake.[86] Evidence of the psychosocial implications of living alone for eating are consistent with the findings reported in the current review, whereby intakes in individuals living alone were both higher and lower than those observed in individuals living with others.

Some aspects of living alone, such as independence and autonomy, may enhance the ability to comply with healthy eating guidelines.[2] A person living alone does not have to take into account the food likes and needs of other people.[65] The increase in control over the types of foods purchased and available in the home could support behavior-change techniques such as stimulus control. Another implication is that living alone could reflect social advantage because of the relative expense of this lifestyle arrangement, a pattern that appeared to be more common in women than men.[1,2] de Vaus and Richardson[1] also suggested that their finding of social advantage in women living alone could indicate that women may "as a result of their learning and success in the education system be more confident about relying on their own resources in managing life." This could extend to their ability to manage food and nutrition needs. While results were not entirely consistent, the current review did find a pattern suggesting gender differences in some studies that included men and women, with men more likely to show undesirable food intakes.

Implications of findings. The studies reviewed indicate that persons who live alone may be more likely to have an inadequate intake of some core foods, especially fruits, vegetables, and fish. Low intake of core foods is linked to chronic diseases such as cardiovascular disease, diabetes mellitus, and some cancers.[87,88] This review indicates the possible importance of considering living alone in different stages of the nutrition care process. Further, persons living alone are diverse in terms of age, gender, socioeconomic status, and education and are likely to have needs that differ from those of persons not living alone. When assessing individuals, dietitians could collect data on living arrangements, which might indicate possible barriers or enablers toward compliance with recommendations. It is also important to consider living arrangement data when assessing the need for interventions at the group and population levels and to ensure those interventions are not just targeted at couples and families.

There are several specific nutrition strategies that could address some of the possible barriers linked to living alone: cooking skills programs and recipes that focus on preparation of meals for 1 person across a range of budgets; education that addresses purchasing and storage of food; improved availability of healthy foods that can be purchased, prepared, and stored easily; and supplemental food programs and development of socially acceptable opportunities for eating in communal settings. For other health professionals managing the care of people living alone, the results indicate that the potential negative impact of living alone on nutritional status should be considered.

Strengths, limitations, and further research. The results of this review may have been affected by publication bias, since studies not finding an association are less likely to be published. Non-English-language publications were excluded because of a lack of resources for translation, which could introduce language bias. The inclusion of all studies, regardless of quality, could also be a limitation. Given the novelty of this topic, however, the inclusion of all research was deemed warranted, and quality was considered in the interpretation of results. A strength of the review was the number of large, national studies included. However, there was a reliance on cross-sectional data, with only 3 studies investigating whether a change in living arrangements is linked with changes in dietary patterns.[36,62,63] Variation in study design as well as the type and validity of methods used to assess outcomes also complicates the ability to compare studies. Most studies included multivariate analysis, but the range of covariates included was not consistent, particularly for inclusion of marital status. As the review was based solely upon quantitative research, it provides limited insight into the reasons why people living alone show different dietary behaviors. In addition, the focus of the review was single-person households. People living in shared households who are responsible for preparing their own foods are likely to experience similar barriers to healthy eating.

While randomized controlled trials are unfeasible, larger studies that focus on living arrangements and that include possible confounding and effect-modifying variables are needed. Longitudinal research could investigate the influence of the duration of time living alone or the change in living arrangements and add to the small number of longitudinal studies available. For example, there is potential for the use of life-course cohort or panel data that provide information on living arrangements, food or nutrient intake, and related covariates.

CONCLUSION

This study provides the first comprehensive review of research investigating associations between living alone and nutrient and food intake. While the results do suggest differences in the food and nutrient intakes of people who live alone compared with people in other circumstances, further research is needed to investigate these findings and to consider interactions with the myriad complex factors that lead to living alone and the reasons why living alone influences nutrient intake. This could improve understanding of the relationship between living alone and poor health outcomes and inform the development of interventions for individuals, groups, and populations.

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SUPPORTING INFORMATION

The following information is available through the online version of this article at the publisher's website.

Appendix S1 Studies on food and nutrient intakes in persons living alone compared to those with other living arrangements

REFERENCES

1. de Vaus D, Richardson S. Living Alone in Australia: Trends in Sole Living and Characteristics of Those Who Live Alone. Canberra: Academy of the Social Sciences; 2009. Occasional Paper 2009: Census Series No. 4
2. Jamieson L, Simpson R. Living Alone: Globalization, Identity and Belonging. Hampshire, UK: Palgrave Macmillan; 2013.
3. Barrett P, Twitchin S, Kletchko S, et al. The living environments of community-dwelling older people who become frail: another look at the Living Standards of Older New Zealanders survey. Soc Policy J N Z. 2006;28:133–157.
4. Udell J, Steg P, Scirica B, et al. Living alone and cardiovascular risk in outpatients at risk of or with atherothrombosis. Arch Intern Med. 2012;172:1086–1095.
5. Lidfeldt J, Nerbrand C, Samsioe G, et al. Women living alone have an increased risk to develop diabetes, which is explained mainly by lifestyle factors. Diabetes Care. 2005;28:2531–2536.
6. Kharicha K, Iliffe S, Harari D, et al. Health risk appraisal in older people 1: are older people living alone an "at-risk" group? Br J Gen Pract. 2007;57:271–276.
7. Lyon P, Colquhoun A. Home, hearth and table: a centennial review of the nutritional circumstances of older people living alone. Ageing Soc. 1999;19:53–67.
8. de Boer A, Ter Horst GJ, Lorist MM. Physiological and psychosocial age-related changes associated with reduced food intake in older persons. Ageing Res Rev. 2013;12:316–328.
9. Stroup D, Berlin JA, Morton S, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. JAMA. 2000;283:2008–2012.
10. Collins J, Fauser B. Balancing the strengths of systematic and narrative reviews. Hum Reprod Update. 2005;11:103–104.
11. National Institutes of Health, National Heart Lung, and Blood Institute. Quality assessment tool for observational cohort and cross-sectional studies. http://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort.htm. Updated March 2014. Accessed September 19, 2014.
12. 3C Study Group. Vascular factors and risk of dementia: design of the Three-City Study and baseline characteristics of the study population. Neuroepidemiology. 2003;22:316–325.
13. Brown W, Bryson L, Byles J, et al. Women's Health Australia: recruitment for a national longitudinal cohort study. Women Health. 1999;28:23–40.
14. Cox B, Huppert F, Whichelow M, eds. The Health and Lifestyle Survey: Seven Years On. Aldershot, UK: Dartmouth Publishing Co.; 1993.
15. Creagh D, Neilson S, Collins A, et al. Established cardiovascular disease and CVD risk factors in a primary care population of middle-aged Irish men and women. Ir Med J. 2002;95:298–301.
16. de Groot L, Hautvast J, van Staveren W. Nutrition and health of elderly people in Europe: the EURONUT-SENECA study. Nutr Rev. 1992;50:185–194.
17. Hercberg S, Preziosi P, Briancon S, et al. A primary prevention trial using nutritional doses of antioxidant vitamins and minerals in cardiovascular diseases and cancers in a general population: the SU.VI.MAX study – design, methods, and participant characteristics. Control Clin Trials. 1998;19:336–351.
18. Nelson M, Erens B, Bates B, et al. Low Income Diet and Nutrition Survey: Summary of Key Findings. London: The Stationery Office; 2007.
19. Sharkey JR, Horel S, Johnson C, et al. Understanding nutritional challenges faced by older Americans in rural areas: the role of the food environment and neighbourhood characteristics. In: TA Majchrowicz (ed): RIDGE Project Summaries, 2008: Food Assistance and Nutrition Research Innovation and Development Grants in Economic Program. Washington DC: US Department of Agriculture; 2009:10–12.
20. Carbone E, Zoellner J. Nutrition and health literacy: a systematic review to inform nutrition research and practice. J Acad Nutr Diet. 2012;112:254–265.
21. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6:1–6.
22. US Department of Agriculture, Agricultural Research Office. How Does Living Alone Affect Dietary Quality?. Washington, DC: US Government Printing Office; 1994. Home Economics Research Report no. 51.
23. Touvier M, Kesse-Guyot E, Méjean C, et al. Variations in compliance with recommendations and types of meat/seafood/eggs according to sociodemographic and socioeconomic categories. Ann Nutr Metab. 2010;56:65–73.
24. Touvier M, Mejean C, Kesse-Guyot E, et al. Sociodemographic and economic characteristics associated with dairy intake vary across genders. J Hum Nutr Diet. 2011;24:74–85.
25. Touvier M, Mejean C, Kesse-Guyot E, et al. Variations in compliance with starchy food recommendations and consumption of types of starchy foods according to sociodemographic and socioeconomic characteristics. Br J Nutr. 2010;103:1485–1492.
26. Barberger-Gateau P, Jutand MA, Letenneur L, et al. Correlates of regular fish consumption in French elderly community dwellers: data from the Three-City study. Eur J Clin Nutr. 2005;59:817–825.
27. Davis MA, Murphy SP, Neuhaus JM, et al. Living arrangements affect dietary quality for US adults aged 50 years and older: NHANES III 1988–1994. J Nutr. 2000;130:2256–2264.
28. Davis MA, Murphy SP, Neuhaus JM, et al. Living arrangements and dietary quality of older U.S. adults. J Am Diet Assoc. 1990;90:1667–1672.
29. Deeming C. Food and nutrition security at risk in later life: evidence from the United Kingdom Expenditure & Food Survey. J Soc Policy. 2011;40:471–492.
30. Friel S, Kelleher C, Nolan G, et al. Social diversity of Irish adults nutritional intake. Eur J Clin Nutr. 2003;57:865–875.
31. Friel S, Newell J, Kelleher C. Who eats four or more servings of fruit and vegetables per day? Multivariate classification tree analysis of data from the 1998 Survey of Lifestyle, Attitudes and Nutrition in the Republic of Ireland. Public Health Nutr. 2005;8:159–169.
32. Gerrior SA, Guthrie JF, Fox JJ, et al. Differences in the dietary quality of adults living in single versus multiperson households. J Nutr Educ. 1995;27:113–119.
33. Hunter W, McNaughton S, Crawford D, et al. Does food planning mediate the association between living arrangements and fruit and vegetable consumption among women aged 40 years and older? Appetite. 2010;54:533–537.
34. Irz X, Fratiglioni L, Kuosmanen N, et al. Sociodemographic determinants of diet quality of the EU elderly: a comparative analysis in four countries. Public Health Nutr. 2014;17:1177–1189.
35. Larrieu S, Letenneur L, Berr C, et al. Sociodemographic differences in dietary habits in a population-based sample of elderly subjects: the 3C study. J Nutr Health Aging. 2004;8:497–502.
36. Murphy SP, Rose D, Davis MA, et al. Living arrangements over an 8–13 year period and food group consumption by older adults. Nutr Res. 1993;13:1239–1252.
37. Williams L, Ball K, Crawford D. Why do some socioeconomically disadvantaged women eat better than others? An investigation of the personal, social and

environmental correlates of fruit and vegetable consumption. Appetite. 2010;55: 441–446.
38. Maynard M, Gunnell D, Ness AR, et al. What influences diet in early old age? Prospective and cross-sectional analyses of the Boyd Orr cohort. Eur J Public Health. 2006;16:315–323.
39. Shelton NJ. What not to eat: inequalities in healthy eating behaviour, evidence from the 1998 Scottish Health Survey. J Public Health. 2005;27:36–44.
40. Zipp A, Holcomb CA. Living arrangements and nutrient intakes of healthy women age 65 and older: a study in Manhattan, Kansas. J Nutr Elder. 1992;11:1–18.
41. Bae S, Urrutia-Rojas X, Patel D, et al. Comparison of health behaviors among single- and multiple-member households. Am J Health Behav. 2007;31:514–525.
42. Gibson R. Principles of Nutritional Assessment. 2nd ed. New York: Oxford University Press; 2005.
43. Thomson F, Subar A. Dietary assessment methodology. In: A Coulston, C Boushey, eds. Nutrition in the Prevention and Treatment of Disease. 2nd ed. Burlington, MA: Elsevier Academic Press; 2008: 3–22.
44. Donkin AJW, Johnson AE, Lilley JM, et al. Gender and living alone as determinants of fruit and vegetable consumption among the elderly living at home in urban Nottingham. Appetite. 1998;30:39–51.
45. Wakita Asano A, Hayashi F, Miyoshi M, et al. Demographics, health-related behaviors, eating habits and knowledge associated with vegetable intake in Japanese adults. Eur J Clin Nutr. 2009;63:1335–1344.
46. Dynesen AW, Haraldsdottir J, Holm L, et al. Sociodemographic differences in dietary habits described by food frequency questions – results from Denmark. Eur J Clin Nutr. 2003;57:1586–1597.
47. Sharkey JR, Johnson CM, Dean WR. Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. BMC Geriatrics. 2010;10:32. doi:10.1186/1471-2318-10-32.
48. Ball K, Mishra GD, Thane CW, et al. How well do Australian women comply with dietary guidelines? Public Health Nutr. 2004;7:443–452.
49. Rogers S, Pryer JA. Who consumed 5 or more portions of fruit and vegetables per day in 1986–1987 and in 2000–2001? Public Health Nutr. 2012;15:1240–1247.
50. Itoh R, Suyama Y. Sociodemographic factors and life-styles affecting micronutrient status in an apparently healthy elderly Japanese population. J Nutr Elder. 1995;14:39–54.
51. Small SP, Best DG, Hustins KA. Energy and nutrient intakes of independently-living, elderly women. Can J Nurs Res. 1994;26:71–81.
52. Pearson JM, Schlettwein-Gsell D, van Staveren W, et al. Living alone does not adversely affect nutrient intake and nutritional status of 70- to 75-year-old men and women in small towns across Europe. Int J Food Sci Nutr. 1998;49:131–139.
53. Dean M, Raats MM, Grunert KG, et al. Factors influencing eating a varied diet in old age. Public Health Nutr. 2009;12:2421–2427.
54. Temple JB. Household factors associated with older Australian's purchasing a varied diet: results from household expenditure data. Nutr Diet. 2006;63:28–35.
55. Gillman MW, Pinto BM, Tennstedt S, et al. Relationships of physical activity with dietary behaviors among adults. Prev Med. 2001;32:295–301.
56. Holmes BA, Roberts CL. Diet quality and the influence of social and physical factors on food consumption and nutrient intake in materially deprived older people. Eur J Clin Nutr. 2011;65:538–545.
57. Hart A Jr, Tinker L, Bowen DJ, et al. Correlates of fat intake behaviors in participants in the Eating for a Healthy Life Study. J Am Diet Assoc. 2006;106:1605–1613.
58. Whichelow MJ, Prevost AT. Dietary patterns and their associations with demographic, lifestyle and health variables in a random sample of British adults. Br J Nutr. 1996;76:17–30.
59. Villegas R, Salim A, Collins MM, et al. Dietary patterns in middle-aged Irish men and women defined by cluster analysis. Public Health Nutr. 2004;7:1017–1024.
60. Kesse-Guyot E, Bertrais S, Péneau S, et al. Dietary patterns and their sociodemographic and behavioural correlates in French middle-aged adults from the SU.VI.MAX cohort. Eur J Clin Nutr. 2009;63:521–528.
61. Naska A, Fouskakis D, Oikonomou E, et al. Dietary patterns and their socio-demographic determinants in 10 European countries: data from the DAFNE databank. Eur J Clin Nutr. 2006;60:181–190.
62. Walthouwer MJ, Oenema A, Soetens K, et al. Are clusters of dietary patterns and cluster membership stable over time? Results of a longitudinal cluster analysis study. Appetite. 2014;82:154–159.
63. Prevost AT, Whichelow MJ, Cox BD. Longitudinal dietary changes between 1984-5 and 1991-2 in British adults: association with socio-demographic, lifestyle and health factors. Br J Nutr. 1997;78:873–888.
64. Pryer JA, Cook A, Shetty P. Identification of groups who report similar patterns of diet among a representative national sample of British adults aged 65 years of age or more. Public Health Nutr. 2001;4:787–795.
65. Quandt SA, McDonald J, Arcury TA, et al. Nutritional self-management of elderly widows in rural communities. Gerontologist. 2000;40:86–96.
66. Sellaeg K, Chapman GE. Masculinity and food ideals of men who live alone. Appetite. 2008;51:120–128.
67. Sidenvall B, Nydahl M, Fjellstrom C. Managing food shopping and cooking: the experiences of older Swedish women. Ageing Soc. 2001;21:151–168.
68. Sidenvall B, Nydahl M, Fjellström C. The meal as a gift – the meaning of cooking among retired women. J Appl Gerontol. 2000;19:405–423.
69. Wham CA, Bowden JA. Eating for health: perspectives of older men who live alone. Nutr Diet. 2011;68:221–226.
70. Neill C, Leipert BD, Garcia AC, et al. Using photovoice methodology to investigate facilitators and barriers to food acquisition and preparation by rural older women. J Nutr Gerontol Geriatr. 2011;30:225–247.
71. Frongillo EA, Cantor MH, MacMillan T, et al. Who are the recipients of Meals-on-Wheels in New York City?: a profile of based on a representative sample of Meals-on-Wheels recipients, part I. Care Manag J. 2010;11:19–40.
72. Lee JS, Sinnett S, Bengle R, et al. Unmet needs for the Older Americans Act Nutrition Program. J Appl Gerontol. 2011;30:587–606.
73. Menchaca MG. Predictors of Utilization of Long-Term Care, Supplemental Food and Community Programs for Latino Elderly [thesis]. Chicago: University of Illinois at Chicago; 1999.
74. Weddle D, Wilson FL, Berkshire SD, et al. Evaluating nutrition risk factors and other determinants of use of an urban congregate meal program by older African Americans. J Nutr Gerontol Geriatr. 2012;31:38–58.
75. Burns C, Bentley R, Thornton L, et al. Reduced food access due to a lack of money, inability to lift and lack of access to a car for food shopping: a multilevel study in Melbourne, Victoria. Public Health Nutr. 2011;14:1017–1023.
76. Coleman-Jensen AJ. Working for peanuts: nonstandard work and food insecurity across household structure. J Fam Econ Issues. 2011;32:84–97.
77. Duerr L. Food security status of older adult home-delivered meals program participants and components of its measurement. J Nutr Elder. 2006;26:1–26.
78. Lee JS, Frongillo EA. Factors associated with food insecurity among US elderly persons: Importance of functional impairments. J Gerontol B Psychol Sci Soc Sci. 2001;56:S94–S99.
79. Quine S, Morrell S. Food insecurity in community-dwelling older Australians. Public Health Nutr. 2006;9:219–224.
80. Victor C, Scambler S Bond J. Being alone in later life: loneliness, social isolation and living alone. Rev Clin Gerontol. 2000;10:407–417.
81. Perissinotto C, Stijacic Cenzer I, Covinsky K. Loneliness in older persons: a predictor of functional decline and death. Arch Intern Med. 2012;172:1078–1083.
82. Routasalo P, Savikko N, Tilvis R, et al. Social contacts and their relationship to loneliness among aged people – a population-based study. Gerontology. 2006;52:181–187.
83. Grant P. Food for the soul: social and emotional orgins of comfort eating in the morbidly obese. In: J Buckroyd, S Rother, eds. Psychological Responses to Eating Disorders and Obesity: Recent and Innovative Work. West Sussex, England: John Wiley and Sons; 2008:121–137.
84. Ramic E, Pranjic N, Batic-Mujanovic O, et al. The effect of loneliness on malnutrition in elderly population. Med Arh. 2011;65:92–95.
85. Locher JL, Burgio KL, Yoels WC, et al. The social significance of food and eating in the lives of older recipients of Meals on Wheels. J Nutr Elder. 1997;17:15–33.
86. Herman C, Roth D, Polivy J. Effects of the presence of others on food intake: a normative interpretation. Psychol Bull. 2003;129:873–886.
87. National Health and Medical Research Council. Nutrient Reference Values for Australia and New Zealand, Including Recommended Dietary Intakes. Canberra: National Health and Medical Research Council; 2006.
88. National Health and Medical Research Council. Australian Dietary Guidelines. Canberra: National Health and Medical Research Council; 2013.