*Review*

# Demographic and Socioeconomic Factors Associated to Fruits and Vegetables Consumption in Elderly Europeans: A Systematic Review

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**Abstract:** Several epidemiological studies stress the association between a diet based on high fruits and vegetables intake and a better health condition. However, elderly Europeans cannot manage the recommended fruits and vegetables consumption. This systematic review aims to explore the main factors related to fruits and vegetables consumption in elderly Europeans. We conducted literature searches on Medline, Scopus, and Web of Science from inception to May 2022. Published articles including data related to certain fruits and vegetables consumption among elderly Europeans were selected. The New Castle-Ottawa Scale and National Heart, Lung, and Blood Institute tools were used for methodological quality assessment by two authors independently. A total of 60 articles were retrieved, and data from twenty-one high-quality cross-sectional studies and five moderate-to-high-quality cohort studies, including a total of 109,516 participants, were synthesized. Associated factors mostly analyzed were those relating to demographic and socioeconomic status, such as sex, age, marital status, educational level, and income. However, the findings show a high discrepancy. Some evidence suggests a possible positive association, while other evidence shows an inverse or no association at all. The relationship between demographic and socioeconomic factors with fruits and vegetables consumption is not at all clear. More epidemiological studies with an appropriate design and corresponding statistical methods are required.

**Keywords:** elderly people; fruits and vegetables consumption; socioeconomic factors; demographic factors; systematic review

## 1. Introduction

In the next 20 years, an increase by about 45% of the population aged 65 years and over is expected in Europe [1]. This demographic change will have an effect on the incidence of chronic diseases, considering the association between age and multiple health outcomes such as cardiovascular, endocrine, and neurological diseases and osteoporosis [2,3]. Therefore, this situation calls for a major effort to ensure quality of life in our older population. Covering basic needs such as ensuring the consumption of healthy food is the basis for dignified and independent ageing.

Several epidemiological studies stress the importance of decreasing the consumption of simple carbohydrates and increasing high-fiber intake, as well as maintaining frequent physical activity, to prevent chronic diseases and improve human health [4,5]. Dietary patterns with high fruits and vegetables consumption, such as the Mediterranean diet, are associated with a decreased incidence of cardiovascular and endocrine diseases [6,7]. In this sense, a high daily intake of fruits and vegetables in a varied dietary pattern seems to prevent multiple chronic conditions such as cardiovascular disease, kidney disease, metabolic diseases such as obesity and type 2 diabetes, as well as depression [8–11].

At present, the World Health Organization (WHO) recommends a daily intake of five portions of fruits and vegetables [12]. However, only 12% of the European population comply with the five fruits and vegetables consumption per day, and 26% of people over 65 years do not eat any servings of fruits and vegetables. Women are the ones who better comply with the recommendations [13].

Multiple factors can be related to a greater or lesser consumption of fruits and vegetables. Some studies stress a possible relationship with sex, income, or age, as various health problems such as tooth loss, dysphagia, and cognitive problems develop over the years [14]. However, this association differs in other studies. Considering that diet can be critical for modulating the risk of chronic diseases, this systematic review aims to identify the main associated factors with low fruits and vegetables consumption among elderly Europeans.

## 2. Materials and Methods

This review is reported according to the 2020 update of Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) (Supplementary material; Table S2).

### 2.1. Eligibility Criteria and Research Strategy

This review was conducted to explore the main factors associated with fruits and vegetables consumption. The research strategy was built according to the PECOS statement:

- **P**opulation: non-institutionalized elderly people aged between 55 and 80 years old;
- **E**xposure: factors associated to fruits and vegetables intake (gender, age, SES, etc.);
- **C**omparators: lowest fruits and vegetables intake;
- **O**utcome: fruits and vegetables consumption (quantity and variety);
- **S**tudy design: quantitative and qualitative observational studies.

Three databases, Medline, Scopus, and Web of Science, were used for the research. The selection of the included studies was conducted based on previously set selection criteria: (1) quantitative and qualitative observational studies including cross-sectional and cohort design; (2) published from the inception of each database to May 2022; (3) in Spanish, English, or French; (4) conducted in Europe; (5) including non-institutionalized elderly population without specific diseases; (6) analyzing factors associated to fruits and vegetables consumption. Gray literature, books, communications, and reviews were excluded.

The research equation was established using the following keywords:

- Elderly, older, aged, aging, senior*;
- Fruits intake, vegetables intake, fruits consumption, vegetables consumption, food intake, food consumption, healthy food, healthy eating, healthy diet, food deserts;
- Income, lower class, social class, economic, vulnerability*, social, resource, socioeconomic, poverty, inequality*;
- Household, living standard, living alone, cohabiting, loneliness, residence, social relations;
- Occupational level, occupation, employment, retirement*;
- Educational level, education;
- Gender, sex, woman*, man*;
- Ethnic, race.

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*2.2. Quality Assessment*

The quality of the selected studies was assessed independently by two authors (M.K. and C.O.-R), and discrepancies were solved through discussion with a third researcher. In accordance with the study design, three assessment tools were employed. Cross-sectional studies were evaluated using National Heart, Lung, and Blood Institute (NIHLBI) tools [15]. Two items related to a longitudinal design were not considered for cross-sectional studies: (1) sufficient time frame to see an association and (2) participants who did not engage in follow-up. Twelve items related to the research question, selection of participants, participation rate, exposure, and outcome assessment, and confounders control was also assessed. Classification of the studies was carried out based on the following cut-off scores: "0–4, low quality", "5–9, moderate quality", and "10–12, high quality". For cohort studies, the Newcastle–Ottawa tool was used to assess the level of quality [16]. The scale consists in assessing 8 items related to selection, comparability, and outcome. A maximum of 9 stars can be assigned to each study (2 stars can be assigned to the item of comparability). The considered scores were "≥8 stars, high quality", "6 to 7, moderate quality", "≤5 stars, low quality".

*2.3. Data Extraction and Data Synthesis*

Two reviewers (M.K. and C.O.-R) performed the data extraction using a predefined form. The principal information included country, year of publication, study design, sampling strategy, sample size, eligibility criteria, participant characteristics, principal outcome (dietary pattern, diet quality, fruits and vegetables quantity), assessment methods, exposure (associated factors such as socioeconomic factors, educational level, age, sex, and others), controlling factors, and principal outcomes.

Different factors associated with higher or lower consumption of fruits and vegetables were explored, and a narrative synthesis of the consulted articles was conducted for high-quality cross-sectional studies and moderate-to-high-quality cohorts.

## 3. Results

*3.1. Literature Research*

A total of 10,046 articles were retrieved. After removing duplicates, title and abstract screening was carried out, and 111 articles meeting the eligibility criteria were selected for full-text screening (further details in Table S1. Supplementary Material). Finally, 60 records published between 1995 and 2021 were included in our review (Figure 1).

*3.2. Quality Assessment of Included Studies*

Methodological quality was assessed for 60 selected records. The NHLBI quality tool was applied for 51 cross-sectional studies, and the Newcastle–Ottawa Scale for nine cohorts. Regarding cross-sectional studies, 41.21% ($n$ = 21) showed high quality, and 58.8% ($n$ = 30) moderate quality. Weaknesses were mostly observed for the following items: (1) sample-size justification, power, variance, and effect estimation; (2) exposure measurement before the outcome measurement; (3) measurement of the outcome more than once, (4) blinding exposure (Figure 2 and Table S3). From the nine cohort studies assessed, only one showed high quality, while the percentage of low and moderate quality was similar at 44.44% ($n$ = 4) (Table 1).
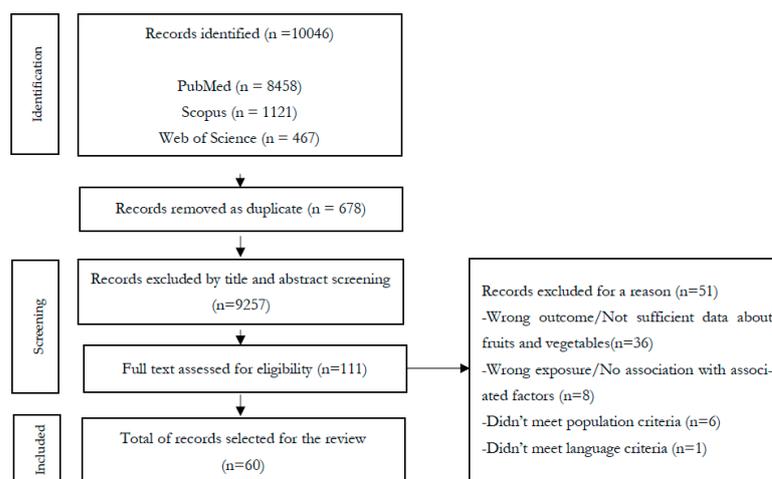
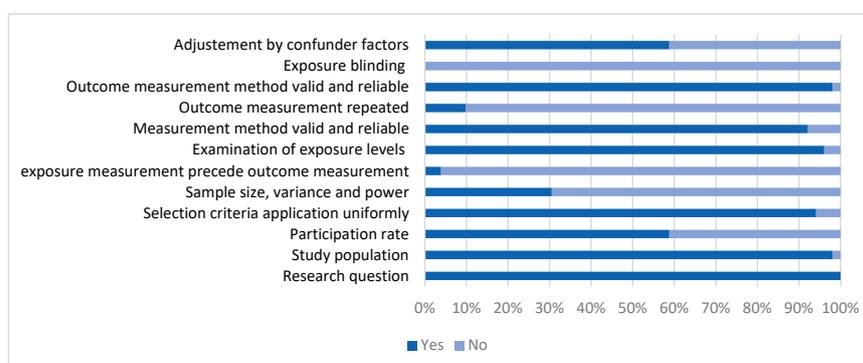**Figure 1.** Flow chart: process applied to select the included studies.



**Figure 2.** Completion of cross-sectional studies using NHLBI quality assessment tool.

**Table 1.** Newcastle–Ottawa Scale assessment of the cohort studies analyzing factors associated to fruits and vegetables consumption.

| | Selection | Comparability | Outcome | Quality |
|---|---|---|---|---|
| Ali-Kovero et al., 2020 [17] | **** | ** | ** | High |
| Boehm et al., 2018 [18] | *** | ** | ** | Moderate |
| Kobayashi el al., 2018 [19] | *** | ** | ** | Moderate |
| Plessz et al., 2017 [20] | *** | ** | ** | Moderate |
| Vinther et al., 2016 [21] | ** | ** | * | Low |
| Plessz et al., 2015 [22] | *** | ** | ** | Moderate |
| Svenja et al., 2005 [23] | *** | None | * | Low |
| Del Pozo et al., 2003 [24] | **** | None | * | Low |
| Schroll et al., 1997 [25] | ** | ** | * | Low |

The asterisks Corresponds to stars described in the methodology of newcastle Ottawa scale.

### 3.3. Characteristics of the Studies

For data synthesis, cross-sectional studies of high quality were analyzed. Regarding cohort studies, moderate-to-high-quality articles were examined as only one study showed high quality. A total of 26 articles were analyzed, including five cohorts and twenty-one cross-sectional. The mean characteristics of cohort studies were summarized in Table 2, and those of cross-sectional ones in Table 3. The distribution of studies according to the geographic area was as follows: five studies were conducted in the United Kingdom (UK) [18,19,26–28], five in the Netherlands [29–33], four in France [20,22,34,35], two in Spain [36,37], Greece [38,39] and Portugal [40,41], and only one study was conducted in each of these countries: Finland, Switzerland, Germany, Italy, and Norway. Finally, one study was multisite, conducted in France, Italy, and the UK.

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**Table 2.** Characteristics of cohort studies analyzing the factors associated to fruits and vegetables consumption.

| 1st Author, Year (Country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/Comparators | Pattern Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Ali–Kovero et al., 2020 [17] (Finland) | 6887 | Employees who had turned 40, 45, 50, 55, or 60 | - Age: women: retired 59.8 (2.6), employed 49.8 (5.5). Men: retired 59.7 (2.9), employed 50.3 (5.7) - Household income (euros/month): women: retired 2866 (1328), employed 3007 (1331). Men: retired 3307 (1278), employed 3244 (1265) | fruits, vegetables, and fish consumption | FFQ | Employment status | Age, marital status, limiting long-standing illness, and household income | - Vegetables consumption 1: women: retired 33.2 (15.8), employed 33.5 (16.3). Men: retired 27.0 (14.7), employed 26.3 (14.7) - Fruits consumption 1: women: retired 33.8 (17.0), employed 30.3 (17.4). Men: retired 22.4 (15.6), employed 19.8 (14.8) - Fish consumption 1: women: retired 7.7 (5.9), employed 7.2 (5.9). Men: retired 7.3 (5.6), employed 6.9 (5.6) |
| Boehm et al., 2018 [18] (England) | 6565 | Population aged 50 years and older | Age average: 65.0 (9.78); 55.4% women; 98.2% white | Fruits and vegetables intake | Interview and self-completion questionnaire | Psychological well-being (low, moderate, high) | Age, BMI, gender, race, socioeconomic status, education, marital status, diseases, smoking, and physical activity | NA |
| Kobayashi et al., 2018 [19] (England) | 3392 | Population aged 50 years and older | Age groups: 39% (52–59) and 38% (60–69); 44% are males; 65% overweight/obese; 71% married or living as married; 15% have a high degree of loneliness | Five daily fruits and vegetables intake. | Interview and self-completion questionnaire. Loneliness: UCLA | Social isolation and loneliness | Age, sex, sociodemographic factors, health indicators, social isolation and loneliness mutually, depression and depressive syndrome | 24% complete with 5 daily fruits and vegetables intake. 25% and 17% from low social isolation and high social isolation groups, respectively. 25% and 21% with low loneliness and high loneliness, respectively |

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**Table 2.** *Cont.*

| 1st Author, Year (Country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/Comparators | Pattern Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Plessz et al., 2017 [20] (France) | 14,019 | 40–49 years in 1989 who reported living with a partner at that time and who were still in the cohort in 2014 | Over 80% of complete-case respondents (92% of women respondents) had initially worked in subordinate positions (men were usually manual workers; women, office workers). The women had lower educational attainment (18% were secondary school graduates, as compared to 47% of the men). In 2014, 88% of respondents were living with a partner; only 3% had experienced more than two union dissolutions | Vegetables consumption | FFQ | Union dissolution (married vs. single) | Geographic area, age, whether retired, presence of children in the home, and 1990 questionnaire | 55.1% of women ate vegetables every day in 2014 vs. 31.2% in 1990. 36.2% of men ate vegetables every day in 2014 vs. 18.6% in 1990. |
| Plessz et al., 2015 [22] (France) | 20,652 | 40–49 years, retired after the first FFQ in 1990 and before the last FFQ in 2009; (d) aged between 50 and 61 years at retirement. Never had long-standing illness or disabilities, according to company records | Mean age men and women: 5.9 (2.8) Medium educational level men/women: 53.4%/51.9% Low educational level men/women: 18.95%/31.9% | Eating vegetables every day | FFQ | Age in years and retirement status | Sex, prescribed diet, changes in spousal status, educational level | NA |

UCLA: University of California Los Angeles Loneliness Scale.

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**Table 3.** Characteristics of cross-sectional studies analyzing factors associated to fruits and vegetables consumption.

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| López-González et al., 2021 [36] (Spain) | 6647 | Men aged between 55 and 75 years and women 60–75 years, with a body mass index between 27 and 40 kg/m$^2$, who meet at least three MetS criteria: abdominal obesity for European individuals (WC of 88 cm in women and 102 in men), high triglyceride levels (150 g/dL; or drug treatment for elevated triglycerides), low HDL-cholesterol (<50 mg/dL in women and <40 mg/dL in men, or drug treatment for reduced HDL-c), high blood pressure (SBP 130 mm Hg or DBP 85 mm Hg, or antihypertensive drug treatment), or high plasma fasting glucose (100 mg/dL, or drug treatment for elevated glucose) | T1 (lowest) ($n$ = 2523) Age: 64.54 ± 5.00 Women (39.95%) BMI, kg/m$^2$: 32.63 ± 3.40 -Abdominal obesity, $n$(%): 2372 (94.02) -Educational level, $n$ (%): primary school 1135 (44.99), secondary school 809 (32.07), tertiary school 579 (22.95) -Marital status, $n$ (%): married 1913 (76.09), widowed 241 (9.59), divorced/separated 210 (8.35), others 150 (5.97), living alone 320 (12.71) -Employment status, $n$ (%): retired 1414 (56.38), employed 583 (23.25), housekeeper 283 (11.28), others 228 (9.09) T3 (highest) ($n$ = 1851) Age: 65.31 ± 4.66 Women: 59.27% BMI, kg/m$^2$: 32.51 ± 3.51 Abdominal obesity, $n$(%): 1760 (95.08) -Educational level, $n$(%): primary school 981 (53.00), secondary school 475 (25.66), tertiary school 395 (21.34). - Marital status, $n$(%): married 1430 (77.38), widowed 206 (11.15), divorced/separated 140 (7.58), other 72 (3.90), living alone 219 (11.83) - Employment status, $n$(%): retired 1021 (55.34), employed 327 (17.72), housekeeper 348 (18.86), other 149 (8.08) | Fruits and vegetables variety and quantity, diet quality | FFQ | Lifestyle (smoking habit, physical activity, WHO exercise recommendations, sedentary behavior, sleeping) | Sex and age | Fruits and vegetables consumption, lowest vs. highest tertiles: 286.87 ± 3.83 vs. 439.41 ± 4.48 and 237.70 ± 2.28 vs. 383.87 ± 2.67, respectively |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Apostolaki et., 2020 [38] (Greece) | 463 | Elderly people from Protection Centers able to understand and respond to the questionnaire independently | 85% males and 15% females. Male mean age was 75.4 (6.1) years, and women mean age 74.4 (6.2). 40.5% of women and 19.1% of men were obese. 70% report primary education | Adherence to the Mediterranean diet, dietary intake | Med Diet Score, water balance questionnaire (WBQ) | Gender | Age, education, marital status, annual income, car ownership, growing vegetables and fruits (Med Diet Score analysis) | Mean of Med Diet Score: 31.9 (3.6). Energy intake was 1678 (412) kcal/day |
| Der Toorn et al., 2020 [29] (Netherlands) | 12,985 | Middle-aged and elderly participants of the Rotterdam cohort | Sex: 58%women vs. 42% men Median (IQR) age: 66 years (59–74) - Education: (68.9%) lower/intermediate - BMI median: 26.5 kg/m² (IQR: 24.3–29.1) | Diet quality | FFQ | Seasonal variation | Sex, age, cohort, energy intake, physical activity, body mass index, comorbidities, and education | - Diet quality score: Winter median: 7 (6–8), Spring median: 7 (5–8), Summer: 7 (5–8), Autumn: 7 (6–8) - Overall median energy intake (Kcal/day): 1996 (1653–2392) |
| Rodrigues et al., 2018 [42] (Portugal) | 2393 | Non-institutionalized adults (65+ years old) living in private residences in the Portuguese Mainland and Islands (Madeira and Azores) | 55.8% were female 65+ years Mean BMI of all older adults was 27.3 ± 5.2 kg/m² 77.9% with household income below 1000 euros per month Lower levels of education were found among the oldest seniors | Dietary habits | FFQ | Age, geographic area | NA | 83.8% consume fruits every day, 59.9% consume vegetables every day Lower consumption of fruits and vegetable sin the Azores (69.0%) and Madeira (73.9%) regions |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Schoufour et al., 2018 [30] (Netherlands) | 5434 | All residents aged 55+ in the Ommoord district | 3210 were female (59%) Age categories: males/females - 55–64 y: 43%/42% - 65–74 y: 40%/37% - 75–84 y: 15%/19% - ≥85 y: 1%/2% Smoking: males/females - Current smoker: 29%/19% - Nonsmoker: 71%/81% BMI: - normal weight: 40%/36% - overweight: 52%/44% - obesity: 7%/19% Household income: - <28,000: 25%/49% - 28,000–39,999: 34%/26% - 40,000–54,999: 28%/18% - >54,999: 13%/7% Education - Primary education: 24% males, 42% females - Lower secondary: 24%/32% - Intermediate: 37%/22% - Higher: 15%/4% | Diet quality | Dutch Healthy Diet Index | Socioeconomic indicators (income, education, occupation) | Sex, age, smoking status, BMI, physical activity level, total energy intake, and mutually adjusted for the other socioeconomic indicators | Fruits consumption was stable in 93% of participants throughout follow-up Vegetables consumption increased in 14% of participants and decreased in 12% |
| Appleton et al., 2017 [43] (France, Italy, UK) | 497 | Aged 65 years or older, able to come to the institution undertaking the research, and able to fully understand and complete the consent and questionnaire | Mean age (SD): 72.1 (6.7). Highest education level: - No qualifications: 198 (40%) - University degree: 47 (9%) Current/most recent employment: - Unemployed: 61 (12%) - Manual worker: 62 (13%) - Non-manual worker: 237 (48%) - Professional/management: 137 (28%) | Quantity and variety of vegetables consumption | Questionnaire self-reported. | Demographic predictors (gender, age, country of residence, highest educational qualification) | NA | Mean quantity of vegetables consumed was low (mean = 2.1–2.7 portions/day) |
| Jimenéz Redondo et al., 2016 [37] (Spain) | 98 | All non-institutionalized residents aged 80 years and above | - Mean age: 86.6 (5.0), 61.5% widowed, 19.4% had a secondary school education, 16.3% living alone | Food-group consumption and nutritional status (MNA) | Mini Nutritional Assessment (MNA) | Gender | NA | Consumption (g/day) men vs. women -Vegetables: 271.7 ± 211.3 vs. 220.3 ± 163.3 - Fruits: 337.2 ± 215.6 vs. 290.7 ± 218.1 |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Dijkstra et al., 2015 [32] (Netherlands) | 1057 | Age <80 years, independently living, cognitively well-functioning and still alive on January 1, 2007 | The total sample included 1057 participants, 555 women and 502 men, with a mean age of 68.9 years (SD: 6.2) (Table 1). More than half of the respondents had both a middle level of education and a middle level of income | Fruits, vegetables, and fish guidelines | FFQ | Perceived barriers on fruits consumption | Sex, age, alcohol consumption, partner status, and the other SES indicators. | Main barriers perceived are related to price and preferences. |
| Dijkstra et al., 2014 [31] (Netherlands) | 1057 | Age <80 years, independently living, cognitively well-functioning and still alive on January 1, 2007 | The sample included 555 women and 502 men, with a mean age of 68.9 years (SD: 6.2). More than half of the respondents had a middle level of education and a middle level of income, 32.3% had a middle level of occupational prestige | Fruits, vegetables and fish intake (adherence to guidelines) | Short FFQ | Socioeconomic status (SES) indicators (education, household income, and occupational prestige) | Sex, age, SES indicators, partner status, and alcohol consumption | Fruits consumption ≥2 pieces/day: 82.5%. Vegetables (≥200 g a day): 65.1%. |
| Oliveira et al., 2014 [41] (Portugal) | 2485 | Non-institutionalized inhabitants of Porto aged ≥18 years. Those aged ≥65 years with no cognitive impairment | Compared to women, men were significantly more educated, often blue-collar workers (married (80.9 versus 60.8%), current smokers (34.7 versus 17.7%), and regular physical exercise practitioners (41.1 versus 31.5%) | Inadequate fruits and vegetables consumption | FFQ | Sociodemographic, Lifestyle, and anthropometric predictors | Age, education, marital status, smoking status, regular physical exercise, and total energy intake | The proportion of consumers of <5 servings per day of fruits and vegetables was 49.2 versus 42.2% in women and men, respectively. In both sexes, the daily mean (SD) consumption of vegetables was significantly higher than that of fruits |
| Danon-Hersch et al., 2013 [44] (Switzerland) | 1260 | 65–70 years old non-institutionalized population living in Lausanne | Age: 65–75 years Prevalence of overweight (BMI 25.0–29.9 kg/m²), obesity (BMI ≥30.0 kg/m²), and abdominal obesity was 53%, 24%, and 45% in men; 35%, 23%, and 45% in women | Eating habits | MNA | Age, living arrangements, financial difficulties, symptoms of depression and education level | Living alone, financial difficulties, symptoms of depression, education level and current smoking | Fruits or vegetables ≥twice/day: men 80.5% and women 90.1 |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Giuli et al., 2012 [45] (Italy) | 306 | 65+ years old healthy, non-institutionalized and did not require day care and/or nursing support volunteers. Free of medication such as steroids, diuretics, anticonvulsants, anti-depressant drugs, antibiotics, antimetabolites, non-steroid anti-inflammatory drugs and micronutrient supplementation | The mean age of the sample was 76.91 (8.5) years. The level of education in male vs. females was 12.8% vs. 6.4% for middle/high education; 56.1% of females were widowed, while 76.7% of males were married 75.7% of men were overweight and obese vs. 44.2% of women. Resources were not sufficient for daily food shopping | Dietary habits and nutritional aspects | FFQ | Sociodemographic and anthropometric factors | No | Fruits are the most consumed food in 7.46 ± 2.6, raw vegetables in 7.02 ± 2.8, other cooked vegetables in 5.58 ± 1.8 |
| Perna et al., 2012 [46] (Germany) | 3942 | Residents in the study region of Augsburg, Germany | Age: 61.8% ≤75 years Sex: 52.5% women Educational level: 68.3% low Household income: 64.0% low Resilience (%) mid and low vs. upper third: 67.2% vs. 32.8%. Physical activity: 86.9% high to moderate 28.4% living alone | Health behavior including fruits and vegetables consumption | Short version of the Resilience Scale (RS), phone interview | Resilience | Educational level, household income | - Low fruits and vegetables consumption: 91.3%. - High fruits and vegetables consumption: 8.7% |
| Katsarou et al., 2010 [39] (Greece) | 1129 | Age: 65+ years Non-institutionalized, non-CVD or cancer | Age: 74 years Sex: 47% male Living in urban areas: 62% Living alone: 28% Smoking current: 14% Physical activity: 36% BMI: 28.6 kg/m² | Adherence to the traditional Mediterranean diet | Mediterranean Diet Score | Socioeconomic status (SES) | Age, sex, place of residence, cohabiting, BMI, physical activity, smoking, presence of diabetes, HTA, and hyperc-holesterolaemia | Fruits consumption in the lowest vs. highest tertiles of SES: 20 ± 6.4 vs. 20 ± 6.7. Vegetables consumption in the lowest vs. highest tertiles of SES: 53 ± 36 vs. 58 ± 35 |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Holmes et al., 2008 [26] (UK) | 234 | 65+ years Either living alone or with other(s) of retirement age | All men Household type: - Living alone: 59% - Living with other(s): 41% Main food shopping: - Large supermarket: 74% - Small supermarket: 26% Transport to main shop: - By car: 57% - Other: 43% Area of residence: - Suburban/rural: 81% - Urban: 19% Income percentage spent on food: - <30%: 77% - 30%: 23% Cooking skills of MFP (main food provider): - Better developed: 75% - Less developed: 25% | Foods consumed and nutrient intake | Dietary data collection used the 24 h recall "multiple pass" method repeated on nonconsecutive days | Social, physical, and other factors such as cooking skills, ability to chew, and isolation. | No | Men with better developed cooking skills as main food providers consume more vegetables (117 g vs. 76 g/day). Approximate consumption of vegetables and fruits among men with difficulties to chew vs. without difficulties: 80 g vs. 119 g/day and 62 g vs. 98 g/day, respectively |
| Samieri et al., 2008 [35] (France) | 1724 | Living in one of these three French cities (Dijon, Bordeaux, and Montpellier), aged 65+, and not institutionalized | Age mean (SD): men vs. women: 76.0 (4.97) vs. 76.8 (5.10) BMI mean (SD) men vs. women: 26.9 (3.59) vs. 26.1 (4.56) Primary or secondary education (%) men vs. women: 53.1% vs. 66.6 Married (%) men vs. women: 78.9% vs. 41.4 | Dietary pattern | FFQ, a 24 h dietary recall | NA | NA | - Mean (SD) fruits serving per week, men vs. women: 13.1 (6.90) vs. 13.7 (7.03) - Mean (SD) cooked vegetables serving per week, men vs. women: 10.1 (4.72) vs. 10.2 (4.24) - Mean (SD) raw vegetables and salad serving per week, men vs. women: 9.3 (4.96) vs. 8.8 (5.46) |
| Elia et al., 2005 [28] (England) | 1155 | 65+ years old Subjects were living freely within the community or in residential accommodation | NA | Malnutrition, nutrient status and nutrient intake | 4 d period by using the weighed food intake method | Geographical factors | Age, gender, and domicile | NA |

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**Table 3.** *Cont.*

| 1st Author, year (country) | Sample Size | Eligibility Criteria | Participant Characteristics | Dietary Pattern/ Comparators | Pattern a\ Analysis Method | Associated Factors Analyzed | Controlling Factors | Outcome |
|---|---|---|---|---|---|---|---|---|
| Larrieu et al., 2004 [34] (France) | 9250 | Subjects aged 65+ recruited in three French cities: Bordeaux, Dijon, and Montpellier | 60.7% women<br>Age (%):<br>- 65–74 y: 5118 (55.3)<br>- 75–84 y: 3597 (38.9)<br>- ≥85 71 y: 535 (5.8)<br>Educational level (%):<br>- low: 2424 (26.2)<br>- middle: 5115 (55.3)<br>- high 1711: (18.5)<br>Lifestyle (%):<br>- alone: 3313 (35.8)<br>- other: 5937 (64.2) | Dietary pattern (raw and cooked vegetables, fruits, and other foods) | Standardized brief FFQ | Sociodemographic factors (sex, age, educational level, lifestyle) | NA | Frequency consumption ≥once a day:<br>- Raw fruits: 78.1%<br>- Raw vegetables: 50.4%<br>- Cooked fruits and vegetables: 68.7% |
| Rossum et al., 2000 [33] (Netherlands) | 5406 | Aged 55+. Living between 1990 and 1993 in a district of Rotterdam, The Netherlands | Mean (SD) age women vs. men: 68 (7) and 67 (8) years, respectively.<br>37% of the population had only attended primary school<br>Men had a higher level of education than women did: 37.1% vs. 21.7% | Nutrient intake (micronutrients, macro, daily intake of some food such as fruits and vegetables, intake of beverages) | semiquantitative FFQ | Educational level and socioeconomic status | Age and gender | Fruits daily intake mean (SD) in grams/day, men vs. women: 206 (131) vs. 243 (131).<br>Vegetables daily intake mean (SD) in grams/day, men vs. women: 221 (92) vs. 219 (123) |
| Johnson et al., 1998 [27] (UK) | 445 | Urban area: non-institutionalized individuals aged 65+ living within the Nottingham area.<br>Rural area: non-institutionalized individuals aged 55+ living within the Nottinghamshire, Lincolnshire, and Leicester-shire areas | Sex (urban/rural) (%):<br>Female: 53.8/58.9<br>Male: 46.2/41.1<br>Age (urban/rural) (%):<br>65–74: 62.8/63.3<br>75+: 37.2/36.7<br>Social class (urban/rural) (%):<br>Professional: 2.5/7.3<br>Managerial: 16.5/39.7<br>Skilled non-manual: 22.7/23.6<br>Skilled manual: 37.7/17.4<br>Semiskilled: 15.1/6.0<br>Unskilled: 5.5/6 | Fruits and vegetables consumption | FFQ | Socioeconomic, physical, and psychological factors (rural vs. urban; smoking, social engagement, sex, age, health score, social class) | Age, income, educational level, and social grade. | Comply with recommended five fruits and vegetables consumption/day, urban vs. rural area: 37% vs. 51%. Low fruits and vegetables consumption was particularly associated with being male, smoking, and having low levels of social engagement |
| Wandel et al., 1995 [47] (Norway) | 1091 | >15 years in Norway (only data related to participants ≥60 was included in our review) | NA | Dietary intake of fruits and vegetables | Personal interview and mail question-naire | Factors limiting the consumption of fruits, vegetables, and potatoes | NA | 52% of participants ≥60 years old comply with daily fruits consumption, and 40% with vegetables consumption |

CVD: cardiovascular diseases; FFQ: Food Frequency Questionnaire; NA: not available.

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Outcomes were averaged by fruits and vegetables consumption or adherence to fruits and vegetables guidelines. Demographic factors were the principal exposure analyzed in eighteen articles. Eleven records report an association between socioeconomic status (SES) and fruits and vegetables consumption. Sample size ranged from 3392 [19] to [22] in cohort studies, and from 98 [37] to [29] in cross–sectional studies.

### 3.4. Association between Demographic Determinants and Fruits and Vegetables Consumption

The association between age and fruits and vegetables consumption is not at all clear. Some studies show an inverse association [20,29,36], other studies report no association at all [35,44]. The effect of age on fruits and vegetables is not the same [45]. Moreover, outcomes can differ depending on geographic area and sex [41,43]. Regarding sex, being female was associated with high fruits and vegetables consumption [20,26,31,33,37]. However, two records do not report any association [39,43]. The findings from one study suggest a significant high fruits consumption in men [45]. Regarding marital status and social isolation determinants, we were not able to clearly define the relationship with fruits and vegetables consumption. High variation was observed in the social situation definition, which makes the comparison less evident. Regarding geographic determinants, fruits and vegetables consumption can be significantly different when comparing countries or regions [28,43]. However, the differences between rural and urban areas are not clear (Table 4).

Other determinants were collected for this inventory (psychological state, smoking habits, cooking skills, and chewing ability). The available data were not sufficient to establish a conclusion regarding these factors (Table S4). Dijkstra et al. stress the price of fruits and vegetables and taste preferences as the principal barriers related to consumption [32]. Wandle's findings relate fruits consumption to preferences, and vegetables consumption to nonfeasting meal patterns [47].

### 3.5. Association between Socioeconomic Status (SES) Predictors and Fruits and Vegetables Consumption

Outcomes related to the association between SES predictors and fruits and vegetables consumption were inconsistent. Some studies show a positive association between educational level [23,24,29,38], economic situation [24,37,39], and fruits and vegetables consumption. However, other studies show an inverse association between educational level and fruits and vegetables consumption [22,41] and no association with economic status [30,45]. Similarly, discrepancies were observed for employment status [17,22]. Outcomes can differ depending on sex [41,44] or geographic area [43] (Table 5).

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Table 4. Association between demographic determinants and fruits and vegetables consumption.

| 1st Author, Year (Country) | Age | Sex | Marital Status/ Social Isolation | Geographic Position |
|---|---|---|---|---|
| López-González et al., 2021 [36] (Spain) | Significant difference | Females had higher variety in fruits and vegetables intake | Significant differences | |
| Apostolaki et., 2020 [38] | | Females had higher daily intake of fruits and vegetables | | |
| Kobayashi et al., 2018 [19] (England) | | | Social isolation was associated with less consumption of fruits and vegetables: RR, 0.80 (0.62–1.04). Loneliness was not associated with 5 fruits and vegetables intake: RR, 0.39 (0.75–1.15) | |
| Appleton K et al., 2017 [43] (France, Italy, UK) | Positive association in UK and French participants, no association for Italian participants | No association with vegetables consumption | | Significant difference between countries and quantity of fruits and vegetables consumption. No effect on variety |
| Plessz et al., 2017 [20] (France) | | | Union dissolution reduced men's vegetables consumption. Women's consumption was more affected if the partner had relatively low socio-occupational status. Living with children was associated with lower vegetables consumption | |
| Jimenéz Redondo et al., 2016 [37] (Spain) | | Men showed high intake of fruits and vegetables (not statistically significant) | | |

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**Table 4.** *Cont.*

| 1st Author,<br>Year (Country) | Age | Sex | Marital Status/<br>Social Isolation | Geographic Position |
|---|---|---|---|---|
| Plessz et al., 2015 [22] (France) | Age was positively associated with high daily vegetables consumption | | Single status was associated with high vegetables consumption | |
| Oliveira et al., 2014 [48] (Portugal) | Age showed an inverse association with fruits and vegetables intake in women | | Marital status showed direct association with fruits and vegetables consumption only in men | |
| Danon-Hersch et al., 2013 [44] (Switzerland) | No association | Male complied less than women did with fruits or vegetables (FV) ≥ twice/day | Living alone was associated with fruits or vegetables consumption ≥ twice/day in men | |
| Giuli et al., 2012 [45] (Italy) | "Raw vegetabless" and "Cooked vegetabless" consumption decreased with age. No change for fruits | Men showed a significantly higher consumption of fruits than women did | | |
| Perna et al., 2012 [46](Germany) | | | No association between living status and fruits and vegetables consumption | |
| Katsarou et al., 2010 [39] (Greece) | No association | No association | No association | No association (rural vs. urban area) |
| Samieri et al., 2008 [35] (France) | No association | | | |
| Holmes et al., 2008 [26] UK | | | Eating alone at the table was associated with highest fruits and vegetables consumption | |
| Elia et al., 2005 [28] (England) | | | | Lower fruits and vegetables intake in the northern region of England as compared to central and southern regions |

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**Table 4.** *Cont.*

| 1st Author, Year (Country) | Age | Sex | Marital Status/ Social Isolation | Geographic Position |
|---|---|---|---|---|
| Larrieu S et al., 2004 [34](France) | Age was associated with lower consumption of raw vegetables | Men consumed more raw vegetables, while women had higher consumption of raw fruits and cooked fruits or vegetables | Living alone was associated with low consumption of fruits and vegetables | |
| Rossum et al., 2000 [33] (Netherlands) | | Women consumed more fruits than men did | | |
| Johnson et al., 1998 [27] (UK) | Vegetables consumption decreased significantly with age | Low fruits and vegetables consumption was particularly associated with being male | Singleness was associated with lower fruits and vegetables consumption in men | Living in a rural area was associated with higher compliance with 5 fruits and vegetables consumption/day |

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**Table 5.** Association between socioeconomic status (SES) determinants and fruits and vegetables consumption.

| 1st Author, Year (Country) | Educational Level | Income/Affluence Score | Employment Status/Retirement |
|---|---|---|---|
| López-González et al., 2021 [36] (Spain) | Significant difference | No difference | No difference |
| Ali–Kovero et al., 2020 [17] (Finland) | | | Statutory retirement was associated positively with fruits consumption in men but negatively with vegetables consumption in women |
| Schoufour et al., 2018 [30] (Netherlands) | Positive association with vegetables consumption. None with fruits consumption | No association | |
| Appleton K et al., 2017 [43] (France, Italy, UK) | Positive association in French and Italian participants. No association in UK participants | Positive association between quantity and affluence score | No association |
| Plessz et al., 2017 [20] (France) | | | Employment position at age 35 was not associated with vegetables consumption |
| Plessz et al., 2015 [22] (France) | Inverse association with vegetables consumption | | Retirement was significantly associated with vegetables consumption for men but not for women |
| Oliveira et al., 2014 [41] (Portugal) | Inverse association in women. No association observed in men | | |
| Danon-Hersch et al., 2013 [44] (Switzerland) | Educational level was associated with fruits or vegetables consumption ≥ twice/day in men | Financial difficulties were associated with less fruits or vegetables consumption in men and women | |
| Giuli et al., 2012 [45] (Italy) | Educational level was significantly and positively correlated with fruits consumption | No association | |
| Katsarou et al., 2010 [39] (Greece) | People in the highest SES group consumed larger quantities of vegetables compared to those in the lowest SES group | | |
| Larrieu S et al., 2004 [34] (France) | Educational level was positively associated with fruits and vegetables consumption | | |

## 4. Discussion

This review proposes an inventory of 21 high-quality cross-sectional studies and five cohort studies with moderate to high quality reporting about associated factors to fruits and vegetables consumption in elderly people. The main associated factors analyzed in the available scientific evidence were age, sex, and determinants related to marital status and SES. Although the association between these determinants and fruit and vegetable consumption may be clear in some age groups, such as in children and adolescents, this association shows greater diversity in older Europeans. On the other hand, other factors such as liking, accessibility, psychological changes, functional disabilities and health consciousness, and knowledge and awareness of current recommendations were suggested as possible factors [49,50].

A scoping review suggests some differences in fruits and vegetables consumption especially by geographic area, socioeconomic status, marital status, and gender. Fruit and vegetables consumption varies widely according to geographical area. In some countries such as the United States, Thailand, and Baltic countries, living in a rural area was negatively associated with fruits and vegetables consumption [50,51]. However, this association does not seem accurate in all European populations. Several countries, especially those in the Mediterranean basin, such as Italy, Spain, and Greece, show high fruits and vegetables intake [43,49]. Being married and a high socioeconomic status were positively associated with fruits and vegetables consumption. Regarding gender, women tend to comply better with the recommendations than men do [14]. On the other hand, although gender shows a difference in consumption among the younger group, this relationship was not distinctive among the oldest group [51]. Articles excluded for quality show similar results regarding variability in the association of determinants such as gender and geographic area on fruits and vegetables consumption. A comparison between geographic areas, defined as countries or regions, shows some differences [52,53]. However, no difference was observed between rural and urban areas [54].

Our conclusions related to advanced age were similar to those reported previously for adults [55]. However, outcomes from other studies show a potential positive association between determinants such as income, educational level, and physical activity [27,56–58]. Nevertheless, no difference was observed for age, gender, and smoking status in a cross-sectional study of 504 Iranian older adults [58]. These outcomes are opposed to Baker et al.'s findings, as their outcomes on 1024 UK older adults confirm that men consume less fruits and vegetables than women do [59].

This inconsistency between various findings may be explained by the particular characteristics of participants, as belonging to different groups according to geographic area, income level, education, and culture. Determinants are typically affected by other factors. Cooking skills in British men was associated to a better consumption of fruits and vegetables [60], although other factors such as living alone may influence the ability to cook. Moreover, this cannot be generalized to other cultures or countries. On the other hand, living in some geographic areas showing less fruits and vegetables intake, such as a rural area or shanty town, is usually related to the economic situation and educational level. Differences between countries may also be related to cultural factors, as would be the case with the Mediterranean diet.

Other factors may be related to the applied study design and statistical method. Furthermore, this relationship does not look the same for fruits as it does for vegetables. This fact further complicates the comparison, since some studies evaluate fruits and vegetables together and others, separately. Finally, like Niklett et al., we also observed a deficiency in studies that specifically analyze the factors associated to fruits and vegetables consumption [14].

Our systematic review has some strengths: (1) the research was extensive and included a large list of possible associated factors, (2) only high-quality evidence was included in the results, (3) reporting review was conducted according to the PRISMA checklist. However, some limitations must be taken into account when interpreting the results. At the

methodological level, the review protocol was not published previously, and the included articles were not selected in pairs. However, quality assessment and data extraction were performed by two authors independently. The fact that the associated factors were self-reported by participants is another limitation to take into account. Furthermore, it should be noted that different patterns of diet can be observed depending on the stage of aging: young-old or old-old [61].

Identifying the consumption patterns and associated factors allows us to determine population groups at risk of nutritional deficiencies. This would help to guide public health campaigns in promoting healthy lifestyles and habits. Our findings provide a summary of data obtained in the high-quality research. However, conducting second-level epidemiological studies is a necessity in order to draw more definite conclusions regarding the factors associated to fruits and vegetables consumption. Longitudinal studies may help to define a causal pathway.

## 5. Conclusions

Our review provides a summary of moderate-to-high-quality scientific evidence reporting data about potential associated factors to fruits and vegetables intake in elderly Europeans. Fruits and vegetables consumption may be associated to the analyzed predictors. However, confirmation of the presence of a causal relationship was not feasible due to the high level of inconsistency in the available findings. To draw stronger conclusions, more studies with an adequate design and hypothetical constructs such as health consciousness, psychological changes, independence level, and availability and diversity in local shops would be required to explore the factors associated to fruits and vegetables consumption.

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