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Association between socioeconomic status, lifestyle factors and mortality: A scoping review

Zhiwei Lian [a,b], Chunsu Zhu [a,b], Volker Arndt [a], Melissa S.Y. Thong [a,*]

[a] Cancer Survivorship Outcomes and Epidemiology, German Cancer Research Center, Heidelberg, Germany
[b] Medical Faculty, University of Heidelberg, Heidelberg, Germany

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ABSTRACT

Background: Lifestyle factors have been widely discussed as potential mediators of the association between socioeconomic status (SES) and health outcomes. However, no comprehensive review has synthesized existing evidence on the mediating role of lifestyle factors in the association of SES with all-cause mortality and cancer-specific mortality. Therefore, we conducted a scoping review to sum up current evidence and highlight research gaps.

Methods: We systematically searched PubMed, EMBASE, and Web of Science from database inception to March 31, 2026 for observational studies that explicitly assessed the mediating role of lifestyle factors in the associations between SES and all-cause mortality or cancer-specific mortality.

Results: Twenty-five longitudinal studies published between 2008 and 2025 were included, predominantly from high-income countries. The median proportions of the associations between SES and mortality mediated by lifestyle factors were modest, ranging from 5.4% to 28.0% for all-cause mortality and from 10.7% to 25.6% for cancer-specific mortality, with substantial heterogeneity across SES indicators, population subgroups, lifestyle measurement approaches, and analytic methods. Smoking consistently showed the strongest mediating role, whereas BMI contributed minimally. Studies using repeated or non-baseline assessments of lifestyle tended to report larger mediation effects.

Conclusion: There is evidence that lifestyle factors (in particular smoking habits) partially mediate the association between SES and all-cause and cancer-specific mortality. However, the magnitude of this mediation is highly sensitive to measurement strategies and study context. Future studies should adopt longitudinal and life-course designs with repeated measures of SES and lifestyle factors, and expand research to low- and middle-income countries to provide globally relevant evidence.

1. Introduction

Socioeconomic status (SES) reflects an individual's position within the social hierarchy and is typically measured as a combination of educational attainment, occupation, and income (Adler and Ostrove, 1999; Baker, 2014). It has long been recognized as a key determinant of both all-cause and cause-specific mortality (Zhang et al., 2021). Despite overall increases in life expectancy, socioeconomic disparities in mortality persist (Marmot et al., 2012; Stringhini et al., 2017). Individuals with lower SES face a higher risk of adverse health outcomes compared to those with higher SES (Stringhini et al., 2010).

Modifiable lifestyle factors, such as smoking, alcohol consumption, diet, body weight, and physical activity, are commonly regarded as mediators of the relationship between SES and health outcomes (Petrovic et al., 2018). Individuals with low SES are more likely to adopt unhealthy lifestyles, which may contribute to health disparities (Allen et al., 2017; Kraft and Kraft, 2021). However, the extent to which adopting a healthier lifestyle can mitigate these disparities remains inconsistent across studies (Petrovic et al., 2018; Stringhini et al., 2010; Zhang et al., 2021). These variations may arise from methodological differences across studies, such as the measurement of both SES and lifestyle factors. For instance, SES can be assessed at the individual level using a single dimension (e.g., education, income, or occupation) (Huisman et al., 2013), as a composite measure combining multiple

* Corresponding author. Cancer Survivorship Outcomes and Epidemiology, German Cancer Research Center (DKFZ), Im Neuenheimer Feld 280, 69120, Heidelberg, Germany.
E-mail address: m.thong@dkfz-heidelberg.de (M.S.Y. Thong).

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dimensions (Khalatbari-Soltani et al., 2020a), or at the area-based level (Moss et al., 2021). Similarly, lifestyle factors can be examined individually or as part of an overall lifestyle pattern, as research suggests that unhealthy behaviors often cluster within individuals (Meader et al., 2016). In addition, both SES and lifestyle factors are dynamic (Barakat and Konstantinidis, 2023; Stringhini et al., 2010), and the changes over time may influence their mediating effects. Furthermore, regional differences in lifestyle habits, cultural factors, social welfare levels, and economic development, as well as variations in study populations and statistical methods for assessing mediation effects, can all impact the mediating role of lifestyle factors (Stringhini et al., 2011; Zhang et al., 2021).

The relationship between SES, lifestyle factors, and mortality may vary substantially across the life course. A life-course perspective highlights that socioeconomic exposures accumulate across adulthood and shape later health outcomes (Dannefer, 2003). Within this perspective, age may serve as an important effect modifier: younger adults may show stronger lifestyle-mediated effects, whereas estimates in older adults may be attenuated by survivor bias, as individuals with a lower SES and less healthy lifestyles may already have experienced earlier mortality (Nordahl et al., 2014). Furthermore, SES should not be regarded as a static construct. Changes in socioeconomic position over time may alter both access to resources and the patterns of lifestyle behaviors (Gugushvili et al., 2022). From a pathway perspective, SES may influence mortality indirectly through behavioral factors, and these pathways may vary across ages, cohorts, and periods of socioeconomic change (Wagner et al., 2024). However, the extent to which lifestyle factors mediate the SES-mortality association from a life-course perspective remains incompletely characterized in existing syntheses.

Cancer is a leading cause of death globally and shows clear socioeconomic patterning (Vaccarella et al., 2023). In addition, lifestyle factors are well-established modifiable contributors to mortality among survivors of cancer (Zhu et al., 2024, 2026). However, the pathways linking SES, lifestyle factors, and cancer mortality may operate differently from those for other causes of death. In particular, cancer comprises a heterogeneous group of diseases with more site-specific etiological pathways and often longer latency periods (Nadler and Zurbenko, 2014), which may make the cumulative impact of long-term lifestyle exposures especially important. Prior evidence syntheses on lifestyle-mediated socioeconomic inequalities in mortality have largely focused on cardiometabolic outcomes and all-cause mortality (Petrovic et al., 2018), while evidence on cancer-specific mortality remains comparatively limited. Examining cancer-specific mortality in addition to all-cause mortality may therefore reveal distinct patterns of behavioral mediation that could otherwise be obscured.

Despite the growing body of research in this area, few studies have synthesized the evidence on the mediating role of lifestyle factors in the relationship between SES and all-cause or cancer-specific mortality. A review published in 2018 assessed the contribution of mediators using statistical coefficients such as β, odds ratio, hazard ratio, or risk ratio, and recalculated the contribution of health behaviors using the difference method. That review found that health behaviors partly accounted for the association between lower SES and increased all-cause mortality, with their explanatory contributions ranging from 43% to 261% (Petrovic et al., 2018). Moreover, since then, this field has undergone methodological developments. Recent studies have increasingly employed composite lifestyle indices rather than examining individual behaviors in isolation (Huang et al., 2025; Shang et al., 2025), adopted multidimensional SES measures (Shang et al., 2025; Z. Wang et al., 2023), and incorporated dynamic, longitudinal assessments of lifestyle factors (P. Wang et al., 2024). Additionally, more advanced analytical approaches, such as marginal structural models, have been used in recent publications. Given these developments, we anticipated that an updated review might reveal more heterogeneous and more nuanced mediation patterns than those reported in earlier recalculation-based syntheses. Therefore, an updated synthesis of current findings is needed to provide new insights into the role of lifestyle factors in health disparities and to inform efforts aimed at reducing socioeconomic inequities in health.

To address these gaps, we conducted a scoping review to synthesize current evidence on the role of lifestyle factors in mediating the associations between SES and all-cause and cancer-specific mortality. This review aims to: (1) provide an updated overview of the evidence, including new studies and methodological advances since Petrovic et al. (2018); (2) characterize the range and sources of heterogeneity in mediation estimates; and (3) identify gaps in the literature to guide future research on the interplay between SES, lifestyle factors, and mortality.

2. Methods

This scoping review was registered on Open Science Framework (OSF) (https://osf.io/8dnze). It was conducted in accordance with PRISMA extension for scoping reviews (PRISMA-ScR) (Tricco et al., 2018).

2.1. Search strategy

A comprehensive search was conducted in PubMed, EMBASE, and Web of Science to identify studies investigating the role of lifestyle factors in the association between SES and all-cause or cancer-specific mortality. The initial search covered studies published from database inception to September 29, 2025. A subsequent update search was conducted up to March 31, 2026 and was performed independently by ZL and CZ. Detailed search strategies are provided in Supplementary Table S1. In brief, the search strategy included Medical Subject Headings (MeSH) and related exploded terms, as well as keywords covering the following themes: "lifestyle", "mortality", "socioeconomic status", "contribution", "cohort study", "cross-sectional study". The search strategy was developed with assistance from a specialist at the university library. Only articles published in English were considered. All retrieved citations were imported into EndNote 20 (Gotschall, 2021) and duplicates were removed.

2.2. Inclusion and exclusion criteria

ZL and CZ performed the study selection independently. Any discrepancies or uncertainties were resolved through discussion with MT and VA. Studies were included if they met the following criteria: (1) study design: cross-sectional or cohort studies; (2) outcomes: all-cause mortality or cancer-specific mortality; (3) population: studies conducted in the general population, including participants with or without a history of cancer; (4) exposure and mediators: SES was the primary exposure, and lifestyle factors were examined as mediators in the association between SES and mortality. SES measures included individual- and/or area-based indicators, such as education, occupation, and income. Lifestyle factors included, but were not limited to: smoking, alcohol consumption, physical activity/sedentary behavior, overweight/obesity, diet, and sleep duration. Both individual lifestyle factors and composite lifestyle indices were considered; (5) analytical approach: studies must explicitly quantify the mediating role of lifestyle factors using either: (a) formal mediation analysis techniques (reporting direct effects, indirect effects, and/or proportion mediated); or (b) attenuation methods (comparing effect estimates such as β coefficients, odds ratios, or hazard ratios with and without lifestyle adjustment, and calculating the proportion of the association attributable to lifestyle factors). Studies reporting only covariate-adjusted associations without explicit mediation quantification were excluded; (6) English language restrictions were applied. Studies were excluded if they met any of the following criteria: (1) study population: studies focusing on populations with pre-existing non-cancer diseases; (2) duplicate publications: reports using the same dataset without providing additional insights; (3)

publication type: protocols, reviews, health education programs, randomized controlled trials, and non-peer-reviewed articles.

2.3. Data extraction

A standardized data extraction table was developed by the research team to systematically collect relevant information from the included studies. The following details were recorded: (1) general publication details: author (s), year of publication, and study country; (2) study characteristics: survey period, age at baseline, sample size, and mean or median follow-up durations; (3) outcome measures: all-cause mortality or cancer-specific mortality; (4) exposure and mediator variables included SES and lifestyle factors.

SES was measured using indicators like education, income, occupation, and wealth at the individual level. We also noted whether a composite SES index was created from these individual measures or if area-level SES indicators were used. Lifestyle factors were recorded, including but not limited to smoking, alcohol consumption, physical activity, and diet. Additionally, we extracted information on whether a composite lifestyle index was created, and we also noted the timing of the lifestyle assessment (e.g., at baseline or non-baseline).

2.4. Mediation analysis

Although scoping reviews do not typically involve formal quantitative synthesis, we conducted a descriptive summary to facilitate comparisons across studies and to account for the complexity of the findings. We also systematically collected specific quantitative data from each study, including the statistical methods used, the effect estimates from the base model (adjusted for covariates but not lifestyle factors), the effect estimates from the lifestyle-adjusted model, and the mediation proportion for each study. In addition, we calculated the minimum, maximum, and median mediation proportions of lifestyle factors in the association between SES and mortality further stratified by relevant subgroups. Using the same approach, we also summarized the mediation effects of individual lifestyle factors. The results of this analysis were presented using tables and box plots.

3. Results

3.1. Study selection and characteristics

Our literature search identified 43,787 unique citations, of which 43,641 articles were excluded after screening of the titles and abstracts. From the 146 articles selected for full reading, 121 were excluded. Finally, 25 articles were included. Detailed selection procedure is shown in Fig. 1.

3.2. Study characteristics

Table 1 presents the characteristics of the included studies. Although the eligibility criteria allowed both cross-sectional and cohort studies to be included, all studies that met the final inclusion criteria were longitudinal and were published between 2008 and 2025. Twenty-two studies were conducted in high-income countries according to the World Bank classification (World Bank, 2025), including participants from the United States (US), Italy, Sweden, Australia, the Netherlands, Norway, the United Kingdom (UK), Denmark, Northern Ireland, France, Finland, while three studies were conducted in China (Q. Cao et al., 2025; Z. Wang et al., 2023; Zhang et al., 2022). Most were from the US (n = 8) and the UK (n = 5). Four international studies collected data from two countries (Stringhini et al., 2011; Woodside et al., 2012; Yarnell et al., 2012; Zhang et al., 2021), while the rest of studies were based in a single country. All participants were adults, and two studies specifically focused on older adults (≥65 years) (Khalatbari-Soltani et al., 2020a; Z. Wang et al., 2023). Sample sizes ranged from 480 to 415,764 individuals, with mean or median follow-up durations ranging from 4.8 to 24.0 years. Three studies included only men (Khalatbari-Soltani et al., 2020a; Woodside et al., 2012; Yarnell et al., 2012), and twelve studies reported sex-specific results for men and women, either in the main analysis or in subgroup analyses (Federico et al., 2013; Laaksonen et al., 2008; Nordahl et al., 2014; Oude Groeniger et al., 2017; Piccinelli et al., 2018; Puka et al., 2022; Shang et al., 2025; Skalická et al., 2015; Z. Wang et al., 2023; Whitley et al., 2014; Zhang et al., 2021; Zhang et al., 2022). Eighteen studies

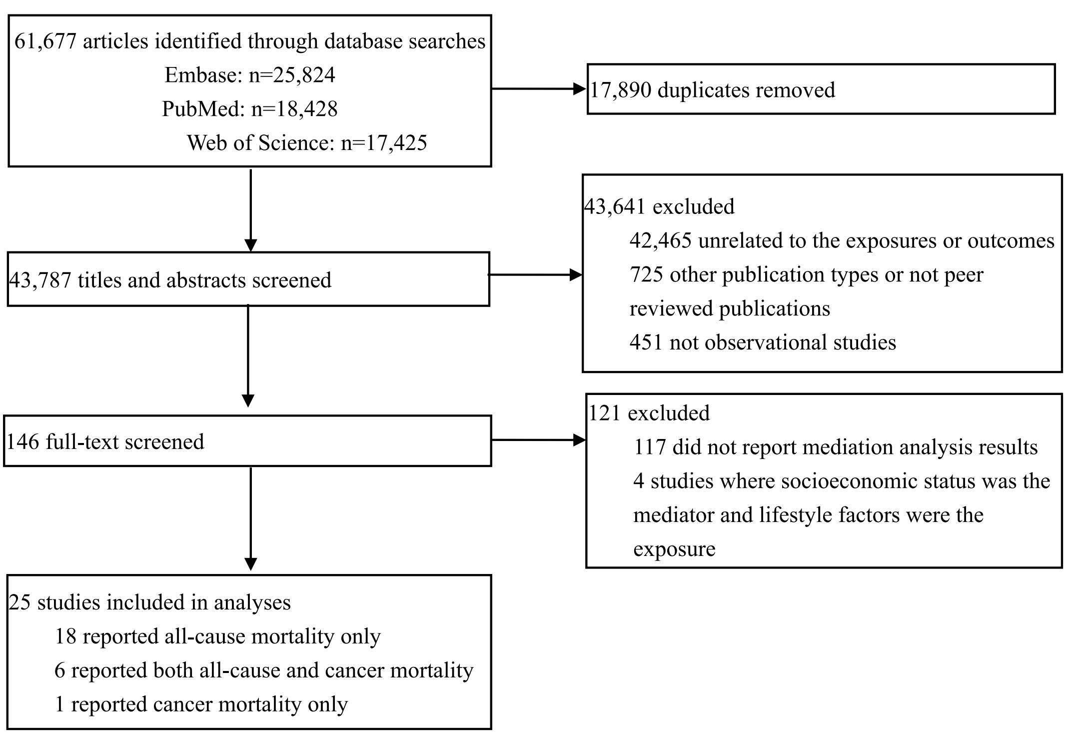

Fig. 1. Flowchart of study selection.

Table 1
Characteristics of included studies.

Author, year	Country	Survey period	Study name	Age at baseline (years)	Number of participants	Outcome (s)	Follow-up duration (years)[a]
Q. Cao et al. (2025)	China	2011-2021	4C Study	≥40	174,004	All-cause mortality	10.1
Shang et al. (2025)	US	2000-2019	NHANES	≥20	2411	All-cause mortality and cancer mortality	9.0
Huang et al. (2025)	UK	2006-2021	UK Biobank	40-73	341,632	All-cause mortality and cancer mortality	11.7
P. Wang et al. (2024)	US	1988-2019	HPFS, NHS, NHS II	25–75	141,145	All-cause mortality and cancer mortality	22.0
Z. Wang et al. (2023)	China	2002-2014	CLHLS	≥65	22,093	All-cause mortality	4.9
Zhang et al. (2022)	China	1991-2011	CHNS	≥18	21,133	All-cause mortality	15.2
Puka et al. (2022)	US	1997-2014	NHIS	25-84	415,764	All-cause mortality	8.8
Zhang et al. (2021)	US	1988-2015	NHANES	≥20	44,462	All-cause mortality	11.2
Zhang et al. (2021)	UK	2007-2018	UK Biobank.	37-73	399,537	All-cause mortality	11.0
Khalatbari-Soltani et al. (2020a)	Australia	2005-2017	CHAMP	≥70	1527	All-cause mortality and cancer mortality	9.0
Glei et al. (2020)	US	1995-2013	MIDUS	25-74	480	All-cause mortality	NA
Piccinelli et al. (2018)	Italy	1999-2012	NHIS	25-74	85,308	All-cause mortality	12.1
Sydén and Landberg (2017)	Sweden	2002-2007	Stockholm Public Health Survey	25-74	21,064	All-cause mortality	5.0
Oude Groeniger et al. (2017)	Netherlands	1991-2013	GLOBE study	25-75	4851	All-cause mortality	NA
Hastert et al. (2016)	US	2000-2010	VITAL	50-76	54,737	Cancer mortality	7.7
Skalická et al. (2015)	Norway	1984-2009	HUNT	25-80	61,513	All-cause mortality	NA
Whitley et al. (2014)	UK	1987-2011	West of Scotland Twenty-07 study	≥35	2994	All-cause mortality and cancer mortality	24.0
Nordahl et al. (2014)	Denmark	1980-2009	Social Inequality in Cancer cohort study	30-70	76,294	All-cause mortality and cancer mortality	15.0
Nandi et al. (2014)	US	1992-2008	Health and Retirement Study	≥51	8037	All-cause mortality	NA
Federico et al. (2013)	Italy	1999-2007	Italian Longitudinal Study	30-74	72,762	All-cause mortality	NA
Yarnell et al. (2012)	Northern Ireland and France	1991-2001	PRIME	50-59	10,600	All-cause mortality	NA
Woodside et al. (2012)	Northern Ireland and France	1991-2001	PRIME	50-59	10,600	All-cause mortality	NA
Jarvandi et al. (2012)	US	1999-2006	NHANES	≥20	9925	All-cause mortality	4.8
Stringhini et al. (2011)	UK	1985-2009	Whitehall II study	35-55	9771	All-cause mortality	19.5
Stringhini et al. (2011)	France	1992-2009	GAZEL study	35-50	17,760	All-cause mortality	16.5
Stringhini et al. (2010)	UK	1985-2009	Whitehall II cohort	35-55	9590	All-cause mortality	19.4
Laaksonen et al. (2008)	Finland	1979-2001	Nationwide Finnish health behaviour surveys	35-64	60,608	All-cause mortality	11.9

Abbreviations: NA Not available.
Country: US United States of America, UK United Kingdom.
Study:4C Study China Cardiometabolic Disease and Cancer Cohort; NHANES National Health and Nutrition Examination Survey; HPFS Health Professionals Follow-Up Study; NHS Nurses' Health Study; NHS II Nurses' Health Study II; CLHLS Chinese Longitudinal Healthy Longevity Survey; CHNS China Health and Nutrition Survey; NHIS National Health Interview Survey (US); CHAMP Concord Health and Aging in Men Project; MIDUS Midlife in the United States study; NHIS Italian National Health Interview Survey (Italy); GLOBE study Health and Living Conditions of the Population of Eindhoven and Surroundings study; VITAL VITamins And Lifestyle Study; HUNT Trøndelag Health Study; PRIME the Prospective Epidemiological Study of Myocardial Infarction;
[a] Follow-up duration refers to mean or median follow-up time, as reported in each study.

examined all-cause mortality only, one study focused exclusively on cancer mortality (Hastert et al., 2016), and six studies investigated both all-cause and cancer mortality (Huang et al., 2025; Khalatbari-Soltani et al., 2020a; Nordahl et al., 2014; Shang et al., 2025; P. Wang et al., 2024; Whitley et al., 2014).

3.3. Measurement of SES

Table 2 presents the measurement of SES and lifestyle factors. SES was primarily measured through educational attainment, occupation, and income. Education was the most common measure (n = 19), followed by occupation (n = 12), income (n = 11), and wealth (n = 2). While many studies used these indicators in combination, eleven studies

Table 2
Measurement of SES and lifestyle factors in included studies.

Author, year	Measures of SES	SES composite index	Components of lifestyle factors	Lifestyle composite Index	Timing of lifestyle measurement
Q. Cao et al. (2025)	Area-level SES	No	Smoking, alcohol consumption, physical activity, diet, sleep	No	Baseline
Shang et al. (2025)	Overall SES (Education, occupation, income, insurance)	Yes	Smoking, alcohol consumption, physical activity, diet	Yes	Baseline
Huang et al. (2025)	Education	No	Smoking, alcohol consumption, physical activity, diet, sleep	Yes	Baseline
P. Wang et al. (2024)	Area-level SES	No	Smoking, alcohol consumption, physical activity, diet, BMI, sedentary, sleep	No	Non-baseline
Z. Wang et al. (2023)	Overall SES (Education, occupation, income)	Yes	Smoking, alcohol consumption, physical activity, diet	Yes	Baseline
Zhang et al. (2022)	Overall SES (Education, occupation, income), area-level SES	Yes	Smoking, BMI, physical activity, diet	Yes	Baseline
Puka et al. (2022)	Education	No	Smoking, alcohol consumption, BMI, physical activity	No	Baseline
Zhang et al. (2021)	Overall SES (Education, occupation, income, insurance)	Yes	Smoking, alcohol consumption, physical activity, diet	Yes	Baseline
Zhang et al. (2021)	Overall SES (Education, employment, income)	Yes	Smoking, alcohol consumption, physical activity, diet	Yes	Baseline
Khalatbari-Soltani et al. (2020a)	Overall SES (Education, occupation, income, housing tenure)	Yes	Smoking, alcohol consumption, BMI, physical activity	No	Non-baseline
Glei et al. (2020)	Overall SES (Education, occupation, income, assets)	Yes	Smoking, alcohol/drug abuse	No	Non-baseline
Piccinelli et al. (2018)	Education	No	Smoking, BMI, physical activity	No	Baseline
Sydén and Landberg (2017)	Education, occupation, income	No	Smoking, alcohol consumption, BMI, physical activity	No	Baseline
Oude Groeniger et al. (2017)	Education, occupation	No	Smoking, BMI, physical activity, sports participation	No	Non-baseline
Hastert et al. (2016)	Area-level SES	No	Smoking, alcohol consumption, physical activity, diet, screening	No	Baseline
Skalická et al. (2015)	Education, income	No	Smoking, alcohol consumption, physical activity	No	Non-baseline
Whitley et al. (2014)	Occupation	No	Smoking, alcohol consumption, physical activity, diet	No	Non-baseline
Nordahl et al. (2014)	Education	No	Smoking, alcohol consumption, BMI, physical activity	No	Baseline
Nandi et al. (2014)	Overall SES (Education, occupation, income, Labor force status, household wealth)	Yes	Smoking, alcohol consumption, physical activity	No	Baseline
Federico et al. (2013)	Education	No	Smoking	No	Baseline
Yarnell et al. (2012)	Education	No	Smoking	No	Baseline
Woodside et al. (2012)	Education	No	Smoking, alcohol consumption, physical activity, diet	No	Baseline
Jarvandi et al. (2012)	Income	No	Smoking, alcohol consumption, BMI, physical activity, diet	No	Baseline
Stringhini et al. (2011)	Education, occupation, income	No	Smoking, alcohol consumption, physical activity, diet	No	Baseline
Stringhini et al. (2011)	Education, occupation, income	No	Smoking, alcohol consumption, physical activity, diet	No	Baseline
Stringhini et al. (2010)	Occupation	No	Smoking, alcohol consumption, physical activity, diet	No	Non-baseline
Laaksonen et al. (2008)	Education	No	Smoking, alcohol consumption, BMI, physical activity, diet	No	Baseline

Abbreviations: SES socioeconomic status, BMI body mass index.

relied on a single SES component exclusively. Most studies used individual-level SES indicators, and four studies incorporated area-level SES measures (Q. Cao et al., 2025; Hastert et al., 2016; P. Wang et al., 2024; Zhang et al., 2022), one of which also included individual-level indicators (Zhang et al., 2022). Additionally, seven studies constructed a composite SES index by combining multiple SES dimensions to reflect overall SES (Glei et al., 2020; Khalatbari-Soltani et al., 2020a; Nandi et al., 2014; Shang et al., 2025; Z. Wang et al., 2023; Zhang et al., 2021; Zhang et al., 2022) with six of these studies published since 2020.

3.4. Measurement of lifestyle factors

All studies included smoking as a lifestyle factor, followed by physical activity (n = 22), alcohol consumption (n = 20), diet (n = 14), BMI (n = 10). A few studies additionally examined other lifestyle factors such as sleep or cancer screening (Q. Cao et al., 2025; Hastert et al., 2016; Huang et al., 2025; P. Wang et al., 2024). The majority of studies examined three or more lifestyle factors, whereas only three studies focused on two or fewer factors. Five studies created a composite index of lifestyle components to represent overall lifestyle factors (Huang et al., 2025; Shang et al., 2025; Z. Wang et al., 2023; Zhang et al., 2021; Zhang et al., 2022), whereas others analyzed each lifestyle factor separately or included them simultaneously in the mediation models. Although most studies assessed lifestyle factors at baseline, seven studies (Glei et al., 2020; Khalatbari-Soltani et al., 2020a; Oude Groeniger et al., 2017; Skalická et al., 2015; Stringhini et al., 2010; P. Wang et al., 2024; Whitley et al., 2014) used non-baseline assessments of lifestyle factors, by either using values closest to the outcome, averaging repeated measures, or modeling them as time-varying variables during follow-up.

3.5. Mediation analysis

Table 3 summarizes the range of mediation effects of lifestyle factors on the association between SES and all-cause or cancer mortality, stratified by SES indicators, health outcomes, age groups, sex, study regions, timing of lifestyle measurement, mediation methods, follow-up durations, and specific lifestyle factor categories. Only results comparing participants with lowest versus highest SES are presented.

Overall, the estimated mediating role of lifestyle factors varied substantially across studies. Across SES indicators, the median proportion of the association between SES and mortality mediated by lifestyle factors was highest for occupation (28.0%), followed by income (13.0%), education (11.1%), and other SES indicators (7.2%). The mediation proportions for cancer-specific mortality were broadly similar to those for all-cause mortality across education (10.7% vs. 11.4%) and occupation (25.6% vs. 28.0%). Estimates for income and other SES indicators showed more variability, likely reflecting the smaller number of cancer-specific mortality estimates available. Overall, the pattern of lifestyle-mediated socioeconomic inequalities for cancer-specific mortality was similar to that for all-cause mortality.

Fig. 2 presents boxplots illustrating the overall distribution of mediation effects after pooling results across all SES indicators. The median proportion of the SES and mortality association mediated by lifestyle factors was 12.7%. The proportion was slightly higher for cancer mortality (13.9%) compared with all-cause mortality (12.3%). The mediation was more pronounced in participants younger than 65 years (10.0%) than in those 65 years or older (1.0%). Although no substantial sex differences were observed in the pooled results (men: 13.1%; women: 13.5%), stratified analysis by individual SES indicators (as detailed in Table 3) indicated a tendency for mediation proportions to be slightly higher among men. Geographically, the mediation effect was greatest in studies from Europe (16.9%), followed by North America (13.9%), and lowest in the Asia-Pacific region (2.8%).

Methodological differences were also associated with variation in mediation estimates. Studies using non-baseline or repeated assessments of lifestyle factors showed more than twice the mediation proportion (24.5%) of those relying on baseline measurements only (10.7%). Similarly, the median mediation proportion derived from marginal structural models (35.0%) was nearly threefold higher than that from conventional regression models (12.3%). Shorter follow-up duration (less than 10 years) was associated with a lower median mediation proportion compared to longer durations (ten years and above). Overall, these findings suggest that mediation estimates are shaped not only by population characteristics, but also by how SES, lifestyle factors, and mediation are measured and modeled across studies.

Fig. 3 shows the contributions of individual lifestyle factors to the mediation of the SES-mortality association. The median mediation proportion of combined lifestyle factors was 17.8%. Among specific lifestyle factors, smoking (26.0%) consistently showed the largest mediation effect, followed by diet (11.9%), physical activity (7.5%), alcohol consumption (7.0%), other lifestyle factors (3.2%), whereas BMI showed the smallest contribution (1.0%). Detailed mediation estimates for each included study are presented in Table S2.

4. Discussion

In this review, we synthesized findings from 25 prospective studies that examined the mediating role of lifestyle factors in the association between SES and all-cause and/or cancer mortality. Our findings confirm that lower SES and unhealthy lifestyle behaviors are individually associated with a higher risk of mortality. This review also shows that lifestyle factors partially mediate the association between SES and mortality. However, the extent of this mediation varied considerably across studies. Several factors may contribute to this variation, including differences in how SES and lifestyle factors were defined and measured, variations in statistical methods, differences in study populations, and

Table 3
Mediation effects of lifestyle factors on the association between SES and mortality by subgroup.

	Education	Occupation	Income	Other SES indicators
Total	11.1[a] (−45.0 to 80.0)[b]; n = 72[c]	28.0 (0 to 77.0); n = 65	13.0 (0 to 56.0); n = 28	7.2 (−15.7 to 75.3); n = 87
Outcome				
All-cause mortality	11.4 (−45.0 to 80.0); n = 60	28.0 (0 to 77.0); n = 59	10.9 (0 to 56.0); n = 27	5.4 (−15.7 to 68.0); n = 61
Cancer mortality	10.7 (−15.0 to 62.0); n = 12	25.6 (0 to 61.0); n = 6	20; n = 1	14.7 (0 to 75.3); n = 26
Age range				
Mix-age group	19.8 (−15.0 to 80.0); n = 42	34.0 (0 to 77.0); n = 49	13.0 (0 to 30.0); n = 18	8.2 (0 to 75.3); n = 54
<65	5.5 (−45.0 to 56.0); n = 30	21.0 (4 to 75.0); n = 16	13.0 (4.0 to 56.0); n = 10	10.8 (2.0 to 44.6); n = 12
≥65	-	-	-	1.0 (−15.7 to 25.0); n = 17
Sex				
Men	14.9 (−45.0 to 66.0); n = 24	42.5 (2.0 to 65.0); n = 10	23.0 (19.0 to 27.0); n = 2	6.0 (−10.8 to 41.9); n = 16
Women	4.5 (−38.0 to 80.0); n = 20	25.0 (0 to 39.0); n = 10	10.0 (3.0 to 17.0); n = 2	8.5 (−7.4 to 16.2); n = 6
Region				
Europe	10.0 (−45.0 to 62.0); n = 69	29.0 (0 to 77.0); n = 64	10.9 (0 to 56.0); n = 27	11.8 (0 to 41.9); n = 23
North America	73.0 (66.0 to 80.0); n = 2	-	-	13.4 (1.3 to 75.3); n = 29
Asia-Pacific	5.8; n = 1	9.4; n = 1	15.3; n = 1	2.0 (−15.7 to 25.0); n = 35
Timing of lifestyle measurement				
Baseline	9.1 (−45.0 to 80.0); n = 68	24.0 (0 to 77.0); n = 51	10.5 (0 to 56.0); n = 26	6.7 (−15.7 to 68.0); n = 63
Non-baseline	49.5 (39.0 to 54.0); n = 4	41.0 (17.0 to 77.0); n = 14	22.0 (17.0 to 27.0); n = 2	12.8 (−7.0 to 75.3); n = 24
Mediation methods				
Regression model	9.6 (−45.0 to 56.0); n = 62	28.0 (0 to 77.0); n = 65	13.0 (0 to 56.0); n = 28	7.2 (−15.7 to 75.3); n = 84
Marginal structural approach	41.0 (−15.0 to 80.0); n = 10	-	-	33.5 (2.6 to 68.0); n = 3
Mean follow-up duration				
≥10 years	7.0 (−45 to 62.0); n = 49	32.0 (0 to 77.0); n = 54	15.3 (4 to 56.0); n = 11	6.5 (0 to 75.3); n = 44
<10 years	22.0 (3.0 to 80.0); n = 9	10.0 (1.0 to 27.0); n = 7	10.0 (0 to 30.0); n = 13	9.7 (−15.7 to 44.6); n = 40
Lifestyle factors				
Combined lifestyle factors[d]	29.7 (−45.0 to 80.0); n = 24	42.0 (6.7 to 77.0); n = 29	20.0 (3.0 to 56.0); n = 11	8.2 (−15.7 to 75.3); n = 56
Smoking	26.0 (−28.0 to 62.0); n = 17	33.0 (4.0 to 49.0); n = 10	8.0 (4.0 to 26.0); n = 4	23.3 (0 to 64.8); n = 7
Diet	11.0 (7.0 to 21.0); n = 4	17.0 (4.0 to 25.0); n = 3	5.0 (0 to 16.0); n = 3	13.3 (1.9 to 18.4); n = 4
Physical activity	7.0 (−14.0 to 10.0); n = 5	3.0 (1.0 to 21.0); n = 9	12.5 (10.0 to 19.0); n = 4	4.7 (3.0 to 10.4); n = 4

(continued on next page)

Table 3 (*continued*)

	Education	Occupation	Income	Other SES indicators
Alcohol consumption	8.0 (4.0 to 22.0); n = 7	4.5 (0 to 18.0); n = 8	8.5 (0 to 17.0); n = 4	2.0 (2.0 to 6.5); n = 4
BMI	0 (−15.0 to 3.0); n = 5	1.0; n = 1	0.5 (0 to 1.0); n = 2	5.1 (−7.0 to 38.3); n = 5
Other lifestyle factors	−3.0 (−30.0 to 9.0); n = 10	42.0 (28.0 to 47.0); n = 5	-	3.7 (1.3 to 14.3); n = 7

Abbreviations: SES socioeconomic status, BMI body mass index.
[a] Values represent median.
[b] Minimum and maximum in parentheses. All values are percentages (%).
[c] Number of associations (one study may contribute multiple associations).
[d] Combined lifestyle factors refer to a lifestyle score constructed from multiple behaviors (e.g., smoking, alcohol use, physical activity, BMI, diet), or the simultaneous inclusion of these variables in a multivariable model.

heterogeneity in study design.

Compared with Petrovic et al. (2018), our review suggests both continuity and change in the evidence base. In terms of the overall magnitude of mediation, Petrovic et al. (2018) reported that the median contributions of health behaviors to all-cause mortality ranged from 20% to 26%, whereas in the present review the corresponding estimates for all-cause mortality were more variable and more modest, ranging from 5.4% to 28%. Despite this difference, one consistent finding across both reviews is that smoking remains the strongest individual mediator of socioeconomic inequalities in mortality. At the same time, the scope of lifestyle factors considered has broadened in more recent studies. Whereas Petrovic et al. (2018) mainly synthesized smoking, physical activity, alcohol consumption, and dietary patterns, the current review also identified studies that incorporated BMI, sleep, sedentary behavior, cancer screening, and, increasingly, combined lifestyle indices (Hastert et al., 2016; Huang et al., 2025; P. Wang et al., 2024). This shift may be important because lifestyle behaviors often cluster and interact rather than operate in isolation. A similar expansion is evident in the measurement of SES: although education, income, and occupation remain central, more recent studies increasingly use multidimensional or composite SES indicators rather than relying on a single socioeconomic dimension (Shang et al., 2025; Z. Wang et al., 2023; Zhang et al., 2022). Nevertheless, both reviews suggest that the mediation proportions tend to be higher when occupation is used as the SES indicator. Methodologically, the present review also highlights developments that were less visible in the earlier synthesis, particularly the use of non-baseline lifestyle assessments and more advanced analytical approaches such as marginal structural models, both of which may better capture the mediating role of lifestyle factors under time-varying conditions.

Taken together, these developments have helped move the field beyond single SES indicators, isolated lifestyle behaviors, and single-timepoint assessments. Composite indices may better capture the co-occurrence of health behaviors, multidimensional measures reflect distinct aspects of social position, and longitudinal assessments suggest that lifestyle factors may have a larger mediating role once cumulative exposure over time is considered (Meader et al., 2016; Oude Groeniger et al., 2017; Stringhini et al., 2010). These approaches offer a more nuanced understanding of how lifestyle factors mediate the association between SES and mortality, while also introducing new challenges, including heterogeneity in score construction, limited comparability across SES measures, and the complexity of accounting for time-varying confounding.

4.1. Indicators of SES

SES is a multidimensional construct that lacks a universally agreed-upon definition. This definitional variability has led to substantial heterogeneity in how SES has been measured across studies. Given its multidimensionality, many studies used multiple indicators, such as

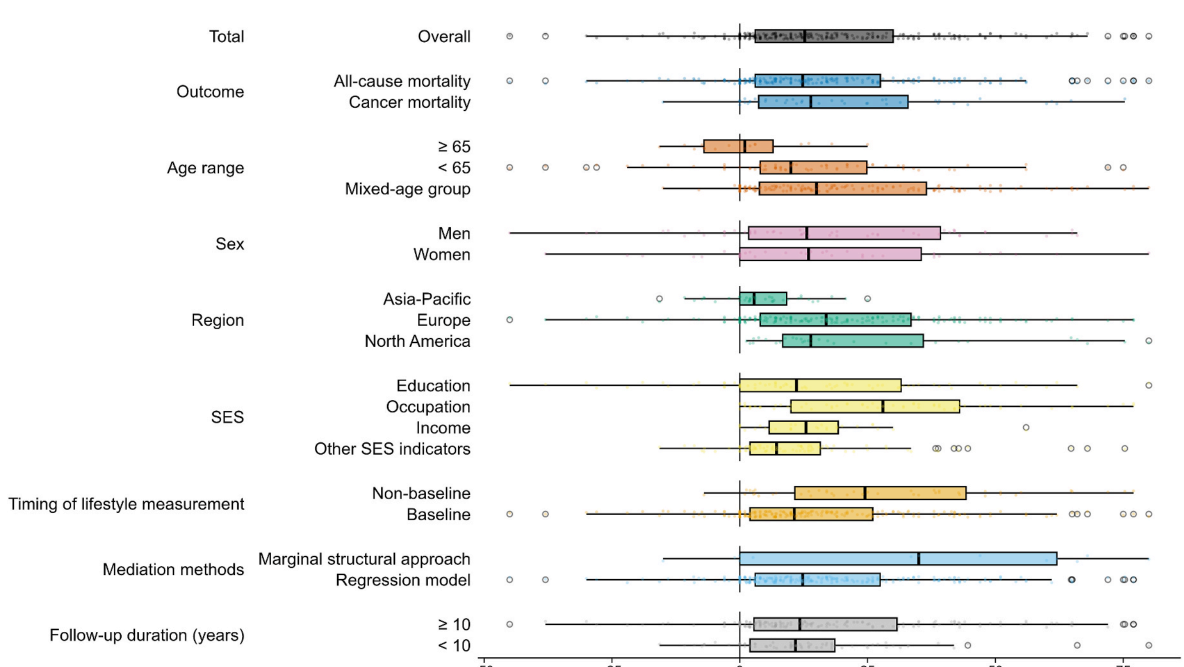

Fig. 2. Mediation proportion of lifestyle factors in the association of SES and mortality across study characteristics
Abbreviations: SES Socioeconomic status.
Mediation proportion (%) was calculated as the percentage reduction in the associations between SES and mortality after adjusting for lifestyle factors in studies using conventional regression methods. Studies using marginal structural models estimated mediation based on counterfactual definitions of natural direct and indirect effects. Overall SES: Constructed using multiple individual-level indicators (e.g., education, income). Baseline: Lifestyle factors measured at study baseline. Non-baseline: Lifestyle factors measured as averages over time, at the most recent follow-up, or modeled as time-varying exposures. Follow-up time was categorized based on the mean or median duration reported in each study.

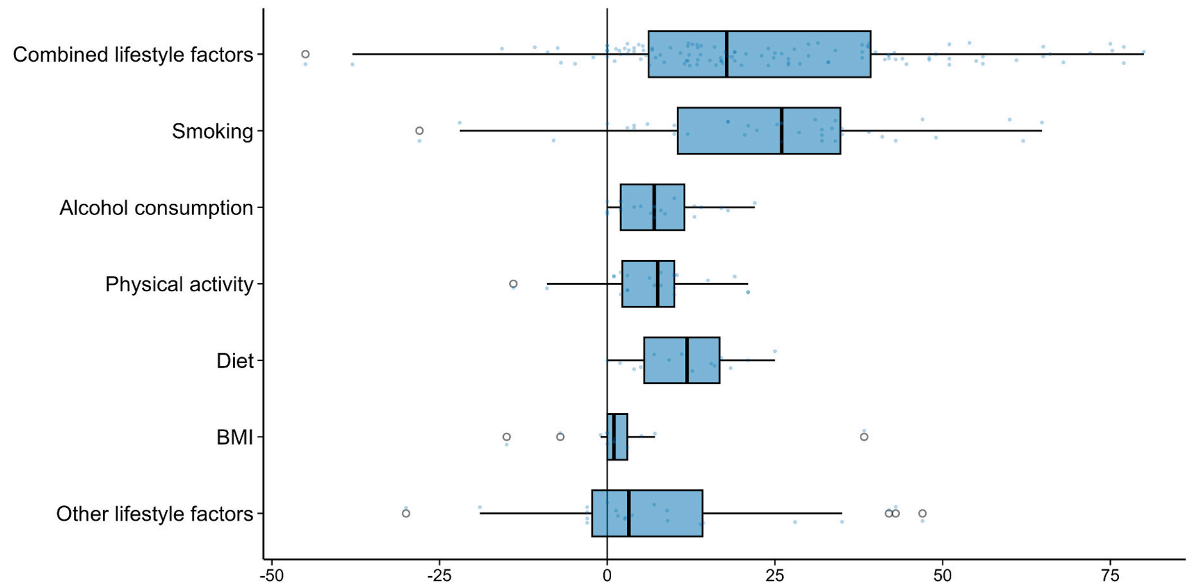

Fig. 3. Mediation effects of specific lifestyle factors in the association between SES and mortality
Abbreviations: SES Socioeconomic status, BMI Body mass index.
Combined lifestyle factors: refer to a lifestyle score constructed from multiple behaviors (e.g., smoking, alcohol use, physical activity, BMI, diet), or to the simultaneous inclusion of these variables in a multivariable model. Other lifestyle factors: Include less commonly assessed behaviors not classified under major lifestyle domains (e.g., screening, alcohol/drug abuse).

education, income, and occupation, to reflect an individual's overall SES. This review shows that education is the most frequently used SES indicator, suggesting its superior comparability and ease of data collection. In contrast, occupation and income were less commonly used, possibly due to the greater difficulty in obtaining these data, such as the complexity of occupational classifications and the sensitivity of income reporting. Notably, eleven studies relied on a single SES component, which may fail to capture the multidimensional nature of socioeconomic position. To address this limitation, several recent studies have applied clustering methods, such as latent class analysis (Zhang et al., 2021), or assigned scores to different SES levels (Z. Wang et al., 2023) to create a composite measure or index that combines multiple SES indicators into a single variable. This approach may better capture individuals' overall socioeconomic position.

The choice of SES indicators should be tailored to specific exposures, health outcomes, and study populations, as their relevance may vary by age and context. For instance, educational attainment reflects early-life and young-adulthood circumstances (Grundy and Holt, 2001). However, when using education as an indicator, the timing of its completion should be taken into account, as this may influence its relevance to current socioeconomic position. Additionally, occupational position typically serves as the primary indicator of adult SES, whereas income is often used to reflect current SES. Furthermore, age must be explicitly accounted for, as the relative importance of different measures changes across the life course. For example, an individual's educational level often shows a weaker association with health outcomes in older adulthood compared with other SES indices, such as wealth or income, which more accurately capture current material resources and living conditions in later life.

Additionally, the cumulative effects of prolonged exposure to socioeconomic disadvantage should be considered (Dannefer, 2003). Evidence from life-course epidemiology indicates that social mobility, which can be integrated into risk accumulation models, is associated with health outcomes (Cable, 2014), and may also influence lifestyle behaviors that link changes in SES to health outcomes, consistent with the pathway model (Wagner et al., 2024). However, few studies have investigated how lifestyle factors mediate the association between SES and mortality within the context of social mobility. Most studies assessed SES at a single time point, typically at baseline, implicitly assuming its stability during follow-up.

While most of the studies included in this review relied on individual-level measures, a few used area-level SES to approximate individual-level SES. Although evidence indicated a fair agreement between area-level SES and individual SES (Moss et al., 2021; Pardo-Crespo et al., 2013), the mediating role of lifestyle factors, particularly how it operates across different levels of SES measurement, remains insufficiently explored. Only one study evaluated both individual- and area-level SES (Zhang et al., 2022). It found that lifestyle factors mediated the association between individual-level SES and mortality but showed no mediation when SES was measured at the area level. This discrepancy likely arises from the inherent limitations of using area-level indicators as proxies for individual SES. Previous research has demonstrated that when area-level SES is used as a substitute for individual measures, associations between SES and health outcomes are often systematically underestimated (Pardo-Crespo et al., 2013). Therefore, studies that employ area-level SES in place of individual SES should carefully consider the selection of indicators and the interpretation of the resulting associations.

4.2. Lifestyle factors

Lifestyle factors may serve as mediators in the relationship between SES and mortality. Our findings confirm that disadvantaged SES is associated with an elevated risk of mortality, partly explained by poorer lifestyle profiles, characterized by lower physical activity levels, unhealthy dietary habits, and higher prevalence of smoking and alcohol consumption. Most studies assessed multiple lifestyle factors, whereas some examined them individually. Lifestyle risk factors often cluster within individuals (Morris et al., 2016), and incorporating a range of lifestyle indicators may provide a more comprehensive assessment of overall lifestyle. Accordingly, recent research has increasingly employed composite lifestyle scores to capture cumulative behavioral risks more effectively. Nevertheless, most studies have applied equal weighting across lifestyle behaviors (Huang et al., 2025; Shang et al., 2025; Z. Wang et al., 2023; Zhang et al., 2021; Zhang et al., 2022), despite the likelihood that these behaviors exert differential influences on health outcomes.

Although lifestyle factors may change over time, the majority of studies relied on baseline measures, which may not fully capture their dynamic nature across the lifespan. Evidence from studies using repeated assessments suggests that certain health behaviors contribute more strongly to the SES-mortality association when measured longitudinally, underscoring the superior predictive value of repeated measures compared with single baseline assessments (Oude Groeniger et al., 2017; Stringhini et al., 2010). Accounting for temporal changes provides a more accurate estimate of the contribution of lifestyle factors to mortality inequalities. This may reflect the fact that health inequalities can widen or narrow over time, patterns that baseline measures alone cannot capture, and that many lifestyle factors exert cumulative effects on health (Doll et al., 2004). Therefore, characterizing trajectories of lifestyle factors is warranted to better understand their long-term impact on health inequalities.

4.3. Mediation analysis

The mediating effects of individual lifestyle factors varied considerably. Smoking consistently exhibited the largest mediating effect, underscoring the importance of smoking cessation in reducing SES-related inequalities in mortality. Individuals with lower SES are more likely to initiate smoking, often influenced by lower parental SES early in life (P. Cao et al., 2023). Crucially, while cessation efforts typically occur later in adulthood, individuals with lower SES face greater challenges in quitting due to higher psychosocial stress and limited access to cessation resources (Businelle et al., 2010; Cook et al., 2025). Socioeconomic disadvantage is also associated with higher smoking intensity (P. Cao et al., 2023). The powerful mediating role of smoking therefore likely reflects both its high prevalence and intensity among disadvantaged groups, as well as its well-established causal links to major causes of death, including cardiovascular disease and cancer (Koene et al., 2016).

In contrast, BMI often showed little mediating effect, which may relate to ongoing debates surrounding the “obesity paradox” (Flegal et al., 2013; Oreopoulos et al., 2009). This paradox may reflect residual confounding by smoking or pre-existing illness, reverse causality due to weight loss preceding death, and the selective survival of metabolically healthier obese individuals. Furthermore, BMI is an imperfect proxy for adiposity, as it does not distinguish regional fat distribution and reflects both fat and lean tissue mass, which may differentially influence health outcomes (Ortiz et al., 2025). These factors collectively may explain why BMI contributed minimally to the mediation between SES and mortality.

When interpreting cross-study differences in mediating effects, it is essential to consider the cultural context of lifestyle factors. We observed substantial regional variation in the extent to which lifestyle factors mediated the SES–mortality association, with the strongest effects reported in Europe, followed by North America, and the weakest in the Asia-Pacific region. For instance, comparative studies in France and the UK demonstrated that although both SES and lifestyle factors were associated with mortality, the mediating role of lifestyle behaviors differed substantially between the two countries (Stringhini et al., 2011), likely reflecting distinct cultural patterns.

As we observed, the median mediation proportion was lower among individuals aged 65 years and older, suggesting that age and cohort effects also warrant attention. The relationship between SES and lifestyle factors may shift over time, thereby altering their mediating influence on SES–mortality associations. One study comparing two birth cohorts found that the adverse impact of low SES on mortality was more pronounced in the younger cohort and was accompanied by stronger attenuating effects of smoking, alcohol use, and diet (Whitley et al., 2014). This generational difference may be explained by shifts in the social distribution of these behaviors. These findings are consistent with the “diffusion of innovation” theory (Kaminski, 2011), which posits that individuals with higher SES are more likely to adopt healthier behaviors earlier. Thus, the stronger mediating role of lifestyle in the younger cohort may reflect an ongoing transition toward healthier behaviors, whereas the older cohort had already experienced earlier shifts, including smoking cessation and dietary improvements. Moreover, participant age may also influence observed mediation effects. Studies focusing on older adults may underestimate the mediating role of lifestyle factors due to survivor bias (Nordahl et al., 2014), as individuals with lower SES are more likely to die earlier, leaving a healthier subset for analysis in later life.

In addition, we found that many previous studies did not report sex-stratified results. In our synthesis, the mediating effect of lifestyle factors on the SES–mortality association differed slightly between men and women, although the differences were modest. Given the well-established sex differences in lifestyle behaviors, prior research has suggested that sex may act as an effect modifier in socioeconomic inequalities in all-cause mortality (Laine et al., 2020). Therefore, conducting sex-specific analyses may provide more accurate and meaningful insights.

Beyond population differences, methodological variations may also account for much of the heterogeneity observed across studies. For instance, studies assessing lifestyle factors at a single time point may underestimate their mediating role in the SES–mortality relationship. In contrast, studies incorporating repeated measures have reported larger mediation proportions, likely because they better capture the cumulative effects of lifestyle over time (Oude Groeniger et al., 2017; Stringhini et al., 2010). Statistical approach also plays a role: estimates from conventional regression models tend to be considerably smaller than those derived from marginal structural models.

The length of follow-up is another critical methodological factor. Because many lifestyle-related health outcomes develop over long periods, short follow-up durations may fail to capture their full impact on mortality (Glei et al., 2020), particularly given the long latency between behavioral exposures and mortality outcomes. Shorter follow-ups also increase the risk of reverse causality, as pre-existing illness may bias estimates by reducing participation in healthy behaviors (Tarp et al., 2020).

Although cross-sectional studies were considered eligible at the protocol stage to ensure a broad search strategy, none met the final inclusion criteria. This likely reflects the fact that temporal ordering is particularly important when evaluating the mediating role of lifestyle factors in the association between SES and mortality. Future reviews in this area may therefore consider restricting eligibility to longitudinal or prospective study designs.

Although we hypothesized that cancer-specific mortality might exhibit distinct patterns of lifestyle-mediated socioeconomic inequalities compared to all-cause mortality, this was not clearly supported by the available evidence. The median mediation proportion for cancer-specific mortality was only slightly higher than that for all-cause mortality, and the contributions of individual lifestyle factors appeared broadly similar across both outcomes, with smoking consistently showing the largest mediating role. The absence of a clearly distinct pattern may partly reflect the limited number of studies.

Several additional limitations are common across current body of evidence. First, only a limited number of included studies examined cancer-specific mortality. Moreover, among these studies, cancer-specific mortality was examined broadly rather than by individual cancer sites. The pathways linking SES, lifestyle factors, and cancer mortality are likely to differ substantially across cancer types. For example, smoking is a dominant pathway for lung cancer mortality, whereas diet, physical activity, and body weight may be more relevant for colorectal and postmenopausal breast cancer (Clinton et al., 2020). Pooling cancer mortality as a broad outcome may therefore mask important site-specific differences in mediating mechanisms. However, the available studies did not report site-specific cancer mortality outcomes with sufficient frequency or comparability to allow a meaningful synthesis by cancer type. Second, most measures of lifestyle factors and SES were self-reported, which may introduce measurement error. Third, some studies constructed composite lifestyle scores by assigning equal weights to each unhealthy behavior, potentially oversimplifying their relative contributions and introducing bias. Finally, the possibility of residual confounding from unmeasured factors, such as adverse early-life experiences, which may persist, should be considered. This may lead to overestimation of the association between SES and mortality. The current evidence base exhibits substantial heterogeneity in the measurement and conceptualization of both SES and lifestyle factors (e.g., choice of SES indicators, construction of lifestyle scores). This variability poses a major challenge to direct comparison and synthesis of findings and contributes to the wide range of reported mediation estimates.

Although modifiable lifestyle factors play an important mediating role in the SES–mortality association and have clear public health relevance for promoting health equity, they do not fully account for socioeconomic disparities in mortality. Additional pathways are likely involved, including unmeasured psychosocial mechanisms (Khalatbari-Soltani et al., 2020b), access to healthcare (Gulati et al., 2025), and biological mechanisms such as inflammation (Muscatell et al., 2020).

4.4. Recommendations for future research

SES should not be regarded as a static construct. Upward or downward social mobility may alter both exposure to socioeconomic resources and the distribution of lifestyle behaviors (Gugushvili et al., 2022), thereby influencing mortality risk through distinct pathways. However, the mediating role of lifestyle factors across different mobility trajectories remains largely unexplored. Future studies can adopt emerging longitudinal datasets with repeated SES measurements to clarify how lifestyle factors mediate the dynamic relationship between SES and mortality.

Moreover, the importance of area-level SES extends beyond its use as a proxy for individual-level SES. It provides valuable contextual information on community resources, environmental quality that independently affect health outcomes (Lawler et al., 2025). Given this dual role, researchers should adopt study designs that include both individual- and area-level SES indicators. Further investigation is needed to clarify the unique contribution of each SES level to the mediation role of lifestyle factors.

As shown in this review, the majority of included studies relied on single baseline assessments of lifestyle factors, which likely underestimates the true mediating effect of behaviors. Studies should prioritize the use of longitudinal data with repeated lifestyle assessments to characterize lifestyle trajectories. Understanding how the trajectory of overall lifestyle (or individual components) changes relative to SES over time is essential for accurately estimating their cumulative contribution to mortality risk.

Furthermore, it is crucial to conduct similarly robust mediation analyses in low- and middle-income countries, which account for the majority of the global population.

Finally, other potential mediators, including access to healthcare, psychosocial factors, biological processes, and social support, should also be considered, as they may contribute both to the SES–mortality association and to the formation of health behaviors.

5. Conclusion

In conclusion, this scoping review indicates that lifestyle factors partially mediate the association between SES and mortality, with smoking consistently showing the largest contribution and BMI contributing the least. The extent of mediation varied across regions, age groups, sexes, measurement approaches, and analytical methods, reflecting substantial heterogeneity in the existing evidence. These findings highlight the public health significance of targeting modifiable lifestyle behaviors, particularly smoking to reduce health inequalities. However, evidence based on the repeated measurements of SES and lifestyle factors across the life course remains limited. Future research should employ longitudinal, life-course designs incorporating repeated assessments of SES and lifestyle behaviors to better capture their dynamic and cumulative effects on mortality.

Ethics statement

No ethics approval required.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT-5 under supervision to check grammar and improve readability. The authors reviewed and edited the content as needed, and take full responsibility for the content of the publication.

CRediT authorship contribution statement

Zhiwei Lian: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Chunsu Zhu:** Formal analysis, Writing – review & editing. **Volker Arndt:** Conceptualization, Supervision, Writing – review & editing. **Melissa S.Y. Thong:** Conceptualization, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2026.119582.

Data availability

No data was used for the research described in the article.

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