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# Determinants of healthy ageing: a systematic review

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## Summary

**Background.** Following the increase in life expectancy, research on determinants of healthy ageing has grown in importance.

**Methods.** The authors aimed to review demographic, lifestyle, social and genetic determinants of healthy ageing. The authors conducted a comprehensive review of the literature and identified 17 prospective studies of determinants of healthy ageing. They abstracted relative risks for gender, marital status, education, income, tobacco smoking, alcohol drinking, physical activity, dietary factors, body weight, hypertension and biomarkers.

**Results.** Low body mass index, avoidance of tobacco smoking and regular/heavy physical activity were consistently associated with increased probability of healthy ageing. A role of alcohol drinking and hypertension cannot be excluded; the data on diet and biomarkers are too sparse to allow any conclusion.

**Conclusion.** Despite some heterogeneity in the design of the available studies, this review identified several important determinants of healthy ageing.

**KEY WORDS:** *alcohol drinking, epidemiology, healthy ageing, physical activity, tobacco smoking.*

**ABBREVIATIONS:** BMI, *Body Mass Index*; CI, *Confidence Interval*; CRP, *C-Reactive Protein*; DBP, *Diastolic Blood Pressure*; EPIC, *European Prospective Investigation into Cancer and Nutrition*; GDS, *Geriatric Depression Scale*; HDL, *High-Density Lipoproteins*; IQ, *Interquartile*; MMSE, *Mini-Mental State Examination*; NAH, *Network on Ageing and Health*; RR, *Relative Risk*; SBP, *Systolic Blood Pressure*.

## Introduction

The world's population is ageing as the result of an overall increase in life expectancy (1). For many people old age is associated with ill health. Chronic illnesses

such as cardiovascular disease, cancer, diabetes and osteoporosis become the leading cause of morbidity, disability and mortality in all regions of the world as people age (1, 2). Healthy ageing, and research into the determinants of healthy ageing, therefore have beco-

me important topics on the agenda of governments, and international agencies (3).

The World Health Organization has stressed that healthy ageing goes beyond avoidance of disease and disability (4). Successful ageing is defined as ageing involving freedom of disability along with high cognitive, physical and social functioning.

Quantitative research on determinants of healthy ageing is needed to understand the mechanisms by which factors that may increase the quality of life in the elderly operate, and to plan and evaluate interventions aimed to prevent avoidable decline in quality of life, and to cure and rehabilitate unhealthy old individuals. However, this field of research remains underdeveloped and the available investigations suffer from methodological limitations, namely lack of data comparability and heterogeneity in the definition of healthy ageing.

Peel and colleagues have recently reported a review of behavioral determinants of healthy ageing (5): in their review, they identified eight studies satisfying their criteria of informativeness: the determinants associated with successful ageing included smoking status, physical activity, body mass index, diet, alcohol drinking, and health practices. However, the amount and quality of evidence available for each of these determinants was rather small.

We aimed to expand this review by including studies reported after the closing date of their literature search, and by considering also social and genetic determinants of healthy ageing. This review is part of the EPIC-Elderly-NAH project, a large-scale investigation of healthy ageing among elderly Europeans (6).

## Methods

We restricted the review to longitudinal prospective studies; cross-sectional studies were excluded because they cannot distinguish the directionality of an association (e.g., tobacco smoking as a determinant rather than a consequence of poor ageing). Furthermore, we did not include studies which looked at determinants of mortality/survival independent from health status. Eight types of determinants: were analyzed in the studies identified for review: (i) demographic factors (e.g., sex, education), (ii) behavioural factors (e.g., tobacco smoking, alcohol drinking); (iii) biomedical factors (e.g., body mass index, blood pressure); (iv) social characteristics

(e.g., social networks); (v) cognitive performance indices; (vi) functional or physical performance indices; (vii) psychological conditions; and (viii) medical conditions. We restricted our review to the first four groups, since determinants in groups (v) through (viii) might be part of the definition of healthy ageing.

We started our review by including the eight studies reviewed by Peel and colleagues (5) (7-14). The reference lists of these papers were searched for additional relevant studies, leading to the identification of two additional studies (15, 16). In addition, we looked for more recent studies via a search on PUBMED. We considered only reports written in English and published in the period January 2003 – February 2007. A preliminary search was done on the presence of following term (HEALTHY or SUCCESSFUL) and (AGEING, AGING, AGED or ELDERLY), which resulted in the identification of 1129 references. The inclusion of one of the following terms: BEHAVIORAL, LIFESTYLE, RISK, PREDICTORS, DETERMINANTS, LONGITUDINAL, FOLLOW-UP or PROSPECTIVE reduced the list to 367 references. The final step in the selection required the inclusion of one of the following keywords: DIET, NUTRITION, LIFESTYLE, PHYSICAL, MENTAL, SOCIAL, SOCIO-DEMOGRAPHIC, EDUCATION INCOME, ANTHROPOMETRY, BODY MASS, WAIST, PHYSICAL ACTIVITY, TOBACCO, SMOKING, ALCOHOL, or DRINKING. After a pre-selection to exclude obviously irrelevant papers, the final list comprised 198 references. Abstracts were distributed to four of the authors (about 50 papers each author) to identify those which seemed relevant for the review. A total of 45 papers were finally selected, and their full text was searched for relevant results. This step lead to the identification of seven relevant studies published after the review by Peel and colleagues (5) (17-23). Therefore, a total of 17 studies were included in our review: their characteristics are summarized in Table 1.

Information on outcome variables (definition of healthy ageing), determinants, and potential confounders was abstracted from the original reports. One of the authors abstracted information from all the studies, in addition data from each study were abstracted by at least one additional author. Most studies included only individuals who were healthy at baseline, or presented results restricted to the healthy part of the cohort; in two studies, however, (7, 8) results were reported for a population comprising healthy and non-healthy individuals at baseline.

Table 1. Characteristics of the studies included in the review.

Reference	Study population, age, country, duration of follow-up	Definition of health	Outcome	Comments	% with healthy ageing
(7)	496 individuals aged 46-70; USA; follow-up 19 years	Top quintile of functional score	Healthy at end of follow-up	Include individuals with low functional score at baseline (adjusted for in the analysis)	21.6
(8)	356 individuals aged 65+; USA; follow-up 6 years	Ability to perform 13 basic activities and no/little difficulty in 5 physical performance activities	Healthy at end of follow-up	Including 42% not healthy at baseline (adjusted for in the analysis)	35.1
(9)	1,889 healthy men aged 45-68; USA (Japanese ancestry); follow-up 28 years	No major illness and physical and mental functions	Healthy aged vs. illness and impairment		32.2
(10)	1097 healthy individuals aged 65+; USA; average follow-up 6.1 years	Living to advanced age with little or no disability	Death above age 80 (men) or 85 (women) with no prior disability		40.3
(11)	487 non-institutionalized individuals aged 70+; USA; follow-up 2 years	Independent living in the community	Remaining independent vs. becoming dependent		20.1
(12)	380 healthy men aged 50; USA; follow-up 30 years	Survival to old age with high level of physical, mental and social well-being	Happy-healthy survivors vs. sad-sick and prematurely dead		41.3
(13)	457 healthy individuals aged 70-75; 19 European cities; follow-up 10 years	Being functionally independent	Remaining independent vs. becoming dependent	95% calculated based on variance of relative risk	83.4
(14)	2932 healthy individuals aged 65+; USA; follow-up 8 years	Being free of major diseases and having normal physical and cognitive functions	Remaining disease-free with normal functions		48.0
(15)	1245 individuals aged 65+; Canada; follow-up 12 years	Composite measure of independence (residence outside nursing home, few days of home care services, self-rated health, etc.)	Remaining independent vs. becoming dependent		46.8
(16)	3,342 healthy individuals aged 65+; USA; follow-up 7 years	No cancer or cardiovascular or respiratory disease	Healthy at end of follow-up		66.5
(17)	1292 individuals aged 67+; Canada; follow-up 6 years	Composite measure of function, including ADL, cognitive and physical impairment etc.	Continuous variable (RR for increase in one unit)	Partial overlap with Ross et al., 1991	
(18)	12,924 healthy individuals aged 50+; Canada; follow-up 2 years	Self-reported health status	Remaining in good health throughout follow-up	No standard error or confidence intervals available	NA
(19)	6,398 healthy individuals aged 35-55; UK; average follow-up 8.8 years	Perceived physical function measured by the Short Form General Health Survey	High physical function at end of follow-up		20.4
(20)	508 healthy and institutionalized individuals aged 65-84; Italy; average follow-up 3.5 years	MMSE $\geq$ 75th percentile and independence in all ADL	Stable positive health vs. negative transition	Non-survivors to age 85 excluded from the analysis	30.9
(21)	288 healthy men aged 70-89; 3 European countries; follow-up 10 years	Disability in instrumental activities, mobility or basal activities in daily living	Lack vs. presence of disability at end of follow-up		36.8
(22)	601 men aged 80+; Australia; mean follow-up 4.8 years	Mental ageing measured by MMSE and GDS-15	MMSE $\geq$ 24 and GDS-15 $\leq$ 5 at end of follow-up		76.0
(23)	2327 healthy men aged 45-68; USA (Japanese in Hawaii); follow-up to 40 years	Survival to age 85 free from chronic diseases and cognitive and physical impairment	Survival to age 85 with chronic disease or cognitive or physical impairment vs. healthy		29.3

MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Scale

With one partial exception (22), risk estimates were based on multivariate models including terms for potential confounders. In one study (13) only 90 per cent confidence intervals were reported: we calculated an approximated value of the 95 per cent confidence interval by deriving the standard error of the logarithm of the odds ratio.

Different studies used different indicators of successful or healthy ageing; moreover, they were not consistent in presenting the results as risk of positive vs. negative outcome. A similar problem arose in the abstraction of data on determinants: the studies under review were not consistent in defining 'at-risk' and 'reference' categories for the determinants under study (e.g., some studies reported risk estimates for smokers vs. non-smokers and other studies reported risk estimates for non-smokers vs. smokers). We decided to report consistently results for successful vs. non-successful ageing, based on consistent definitions of 'at-risk' and 'reference' groups. This implied that for some studies we had to calculate the inverse of the risk estimates.

Some studies (12, 13) reported results separately for men and women or for different sub-cohorts: we combined these results via a meta-analysis based on fixed-effects models (24).

## Results

Among the sociodemographic factors were retained in our review were sex (Table 2a), marital status (Table 2b), education (Table 2c) and income (Table 2d). Furthermore, ethnic group, often operationalized as skin colour or self-reported race, has been considered in several studies, mainly from North America; however, because of the geographic specificity of this variable, we did not consider it in the review. No clear pattern was detected on healthy ageing according to sex (Table 2a). Most studies reporting results on marital status did not detect a difference in probability of healthy ageing between married and unmarried individuals, after adjusting for other determinants (Table 2b). In the case of education (Table 2c) and income (Table 2d), the majority of studies pointed towards a higher probability of healthy ageing for individuals with higher education or income than for other individuals. However, the strength of the association between these social characteristics and healthy ageing varied between studies, likely reflecting differences in both the operational va-

Table 2a. Results of prospective studies of healthy ageing and gender (male vs. female).

Reference	RR	95% CI
(7)	1.2	0.7, 1.9
(8)	1.30	0.79, 2.11
(10)	1.31*	0.97, 1.79
(11)	2.95	1.75, 4.97
(14)	0.89	0.81, 0.99
(16)	0.82	0.72, 0.92
(15)	1.3*	1.0, 1.7
(17)	1.08*	p>0.05
(18)	0.99*	p=0.3

RR, relative risk; CI, confidence interval

\* inverse of original risk estimate

riables used in the various studies and in the way education and income act on health in different countries. Among behavioural factors, tobacco smoking, alcohol drinking, physical activity and diet were reviewed in detail. A total of eleven prospective studies reported results on the role of tobacco smoking on healthy ageing (Table 2e). With few exceptions, these results point towards a strong role of tobacco smoking on the probability of healthy ageing. Heterogeneity in the smoking categories used in the different studies (e.g., combination of ex-smokers either with current smokers in the category of ever smokers or with never smokers in the category of non-current smokers precluded a formal meta-analysis of these data. Interestingly, the studies with the longest follow-up tended to result in stronger associations than studies with shorter follow-up, lending support to the hypothesis that long-term smoking abstinence might indeed play a causal role in healthy ageing. Results on alcohol drinking and healthy ageing do not suggest a strong association (Table 2f): differences in the definition of exposure, and the likely non-linear association between alcohol drinking and several chronic diseases (25) might contribute to the lack of a clear pattern in results. In the case of physical activity, results of ten prospective studies are available (Table 2g). With one exception, these results point towards a higher probability of healthy ageing among individuals engaged in physical activity. Since the ability to perform some form of physical exercise may be part of the definition of healthy ageing, the results presented in Table 2g may simply reflect inverse causality. However, a strong positive association was detected in the studies with ten or more years of follow-up (12, 13), suggesting a real effect of physical exercise on healthy ageing. Two studies reported results on the asso-

Table 2b. Results of prospective studies of healthy ageing and marital status.

Reference	Marital status contrast	RR	95% CI	Comments
(8)	Married vs. other	0.82	0.45, 1.51	
(10)	Married vs. other	0.99*	0.74, 1.32	
(11)	Married vs. other	1.29	0.75, 2.22	
(12)	Stable marriage vs. other	2.35	1.20, 4.63	
(18)	Married vs. widower/separated	1.05	p=0.1	
(22)	Married vs. other	1.02	0.67, 1.54	Univariate analysis

RR, relative risk; CI, confidence interval

\* inverse of original risk estimate

Table 2c. Results of prospective studies on healthy ageing and education.

Reference	Education contrast	RR	95% CI	Comments
(8)	> 12 yrs vs. ≤ 12 yrs	1.67	0.98, 2.84	
(10)	> 12 yrs vs. < 9 yrs	1.18*	0.74, 1.89	
(11)	One additional year (continuous)	0.93	0.77, 1.12	
(12)	One additional year (continuous)	0.86	0.77, 0.96	Analysis restricted to 217 men
(17)	Not specified	0.99*	p>0.05	Education contrast not specified
(18)	University vs. high school	1.06	p=0.001	Dose-response relationship (p<0.001 on four categories)
(20)	Higher than elementary vs. elementary school	2.90	1.68-2.03	95% CI does not match the RR
(22)	High school or education vs. lower education	1.92	1.34, 2.75	
(23)	≥ 12 yrs vs. < 12 yrs	1.56	1.28, 1.91	

RR, relative risk; CI, confidence interval

Table 2d. Results of prospective studies of healthy ageing and income.

Reference	Income contrast	RR	95% CI	Comments
(7)	Adequate/very adequate vs. lower income	3.1	1.4, 10.2	
(8)	Quintiles 2-5 vs. lowest quintile	2.01	0.99, 4.11	
(11)	Adequate vs. non-adequate income	1.44	0.92, 2.25	
(16)	Income > US\$ 25,000 vs. less	1.08	0.96, 1.22	
(18)	Highest vs. lowest quartile	1.08	p<0.001	Dose-response relationship

RR, relative risk; CI, confidence interval

ciation between dietary factors and healthy ageing (Table 2h). As the variables included in these analyses were heterogeneous, no conclusions can be drawn at present. Among the biomedical factors included in the review were abnormal body weight, hypertension and several serological markers. The results of studies on body mass as determinant of healthy ageing are summarized in Table 2i. With one exception, there is strong, consistent evidence of a negative effect of abnormal weight on healthy ageing. Despite the heterogeneity in the definition of healthy ageing and in the categories of body mass index, normal weight individuals had approximately twi-

ce the probability to age healthy as compared to under- or overweight individuals, and this difference was statistically significant in all but one study. Results on the role of hypertension at baseline (either self-reported or based on measurement) on healthy ageing are summarized in Table 2j. Out of six available studies, four resulted in a reduced probability of healthy ageing for individuals with hypertension as compared to individuals with normal blood pressure. In the remaining two studies, no association was detected. Results on serum biomarkers as predictors of healthy ageing are summarized in Table 2k. Two studies which analyzed C-



Table 2e. Results of prospective studies of healthy ageing and tobacco smoking.

Reference	Tobacco smoking contrast	RR	95% CI	Comments
(7)	Current vs. never/ex smoker	0.5*	0.3, 0.8	
(8)	Current vs. never/ex smoker	0.82*	0.40, 1.67	
(9)	Pack-years (IQ range, continuous, decreasing)	0.52	0.39, 0.70	
(10)	Current vs. never smoker	1.04	0.63, 1.69	
(11)	Current vs. never/ex smoker	0.47*	0.22, 0.98	
(12)	30+ vs. < 30 pack-years	0.22*	0.11, 0.41	Meta-an. of 2 cohorts
(13)	Current, ex ≤ 15 years vs. never, ex smoker > 15 years	0.5*	0.2, 1.1	Analysis restricted to 210 men
(14)	Current vs. never/ex smoker	0.77	0.65, 0.90	No dose-response relationship
(16)	Current vs. never smoker	0.66	0.56, 0.78	RR for former smoker 0.78 (95% CI 0.69, 0.88)
(22)	Ever vs. never smoker	0.89	0.63, 1.26	Current vs. never smoker: RR 1.19; 95% CI 0.53, 2.71; univariate analysis
(23)	Ever vs. never smoker	0.81*	0.67, 0.99	

RR, relative risk; CI, confidence interval; IQ, interquartile

\* inverse of original risk estimate

Table 2f. Results of prospective studies of healthy ageing and alcohol drinking.

Reference	Alcohol drinking contrast	RR	95% CI	Comments
(7)	1-60 months/day vs. non-drinker	2.2	1.1, 4.4	
(8)	Non-moderate vs. moderate (4-30 oz/month)	0.68*	0.38, 1.20	
(10)	1+ vs. < 1 oz/day	0.83	0.41, 1.66	
(11)	Current vs. non-drinker	1.00*	0.58, 1.69	
(12)	Abuse vs. no abuse	0.90*	0.39, 1.89	Analysis restricted to 217 men
(16)	Wine drinking	1.04	0.93, 1.17	
(22)	>4 vs. 0-4 drinks/day	0.87	0.42, 1.78	Univariate analysis
(23)	3+ vs. < 3 drinks/day	0.62*	0.48, 0.90	

RR, relative risk; CI, confidence interval; IQ, interquartile

\* inverse of original risk estimate

Table 2g. Results of prospective studies of healthy ageing and physical activity.

Reference	Physical activity contrast	RR	95% CI	Comments
(8)	Walking often vs. other	1.70	0.98, 2.96	
(10)	High vs. low physical activity	1.86	1.24, 2.79	
(11)	Regular vs. not regular exercise	0.99*	0.53, 1.85	
(12)	Exercise >500 kcal/wk vs. less	3.09	1.30, 9.75	Analysis restricted to 162 men
(13)	High and mid vs. low tertile of physical activity	2.3	1.4, 3.6	Meta-an. of men and women
(14)	High vs. low quintile of physical activity	1.27	1.09, 1.47	Dose-response relationship
(16)	High vs. no physical activity	1.42	1.09, 1.85	Dose-response relationship
(19)	Sufficiently active vs. sedentary	1.60	1.30, 1.98	
(21)	High vs. low tertile of physical activity	2.17*	1.19, 3.85	Effect of duration, not intensity of physical activity
(22)	Vigorous vs. no exercise	1.89	1.17, 3.05	Dose-response relationship

RR, relative risk; CI, confidence interval; IQ, interquartile

\* inverse of original risk estimate

Table 2h. Results of prospective studies of healthy ageing and dietary factors.

Reference	Dietary factor and contrast	RR	95% CI	Comments
(13)	High vs. low quality diet	1.1*	0.6, 1.7	Meta-an. of two cohorts
(9)	Japanese diet score; IQ range (increasing)	0.76	0.59, 0.97	

RR, relative risk; CI, confidence interval; IQ, interquartile

\* inverse of original risk estimate

Table 2i. Results of prospective studies on healthy ageing and abnormal body weight.

Reference	Body weight contrast	RR	95% CI	Comments
(7)	Non-moderate vs. moderate weight	0.4*	0.2, 0.9	Meta-an. of two cohorts
(9)	IQ range (increasing)	0.44	0.32, 0.59	
(10)	BMI 27.0+ vs. 21.0-26.9	0.63	0.44, 0.89	
(12)	BMI <22.0 or 28.0+ vs. 22.0-27.9	0.34*	0.17, 0.71	
(16)	Increase in 10 cm waist circumference	1.01	0.96, 1.06	
(20)	Obese vs. normal	0.47*	0.22, 1.01	
(23)	BMI 25.0+ vs. < 25.0	0.67*	0.54, 0.84	

RR, relative risk; CI, confidence interval; BMI, body mass index; IQ, interquartile

\* inverse of original risk estimate

Table 2j. Results of prospective studies of healthy ageing and hypertension.

Reference	Hypertension contrast	RR	95% CI	Comments
(22)	Yes vs. no (self-reported)	0.96	0.68, 1.36	Univariate analysis
(10)	Yes vs. no (self-reported)	1.26	0.94, 1.69	
(9)	IQ range increasing SBP	0.57	0.42, 0.78	
(7)	Yes vs. no (self-reported)	0.2*	0.07, 0.8	
(16)	One standard deviation DPB	0.92	0.87, 0.97	
(23)	≥140/90 mmHg or medication vs. neither	0.62*	0.50, 0.76	

RR, relative risk; CI, confidence interval; DPB, diastolic blood pressure; SBP, systolic blood pressure; IQ, interquartile

\* inverse of original risk estimate

Table 2k. Results of prospective studies of healthy ageing and biomarkers.

Reference	Biomarker and contrast	RR	95% CI	Comments
(14)	CRP; highest vs. lowest quintile	0.77	0.65, 0.90	Dose-response relationship
(16)	CRP, one log unit	0.93	0.88, 0.98	
(9)	Serum glucose, IQ range (increasing)	0.37	0.28, 0.50	
(23)	Serum glucose ≥200 mg/dL vs. lower	0.61*	0.44, 0.83	
(16)	HDL, one standard deviation	1.07	1.01, 1.14	
(23)	Triglycerides ≥150 mg/dL vs. lower	0.79*	0.65, 0.97	

RR, relative risk; CI, confidence interval; CRP, C-reactive protein; HDL, high-density lipoproteins; IQ, interquartile

\* inverse of original risk estimate

reactive protein level resulted in a negative association with probability of healthy ageing; and two additional studies resulted in a similarly negative association with serum glucose level. Results on HDL or triglycerides were also reported in two of these studies, suggesting weak associations with healthy ageing.

Only one study from United States reported results on social determinants of healthy ageing: the RR of being healthy at the end of the follow-up was 1.76 (95 per cent CI 1.02, 3.02) for individuals with 5 or more personal contacts as compared with individuals with less than 5 contacts (8). No results on genetic deter-

minants of healthy ageing were reported in prospective studies.

## Discussion

This review reinforces previous evidence on the important role of lifestyle and behavioral factors as determinants of healthy ageing. The available studies differed in many respects: definition of study population (age restrictions, baseline health status), variables used to define healthy ageing and outcome, potential confounders considered in the analysis. Despite these sources of heterogeneity, however, low BMI, avoidance of tobacco smoking and regular/heavy physical activity were associated in most studies with increased probability of healthy ageing. A role of alcohol drinking cannot be excluded, but is unlikely to be of importance comparable to the factors mentioned above. The data on diet are too sparse to allow any conclusion.

Characteristics related to high social class, such as high education and income, were consistent and strong predictors of healthy ageing. Assuming the association is real, it remains to be established whether confounding by behavioral factors operates here (e.g., individuals of high social class tend to smoke less and to be less frequently overweight and obese). Although many of the measures of association considered in the available studies adjusted for the possible effect behavioral factors, confounding cannot be fully excluded because of possible misclassification of the confounder, and lack of consideration of all relevant lifestyle factors. It is possible however, that high social class is associated with other determinants of healthy ageing, such as healthy diet and physical activity.

In addition to the heterogeneity in the definitions of healthy ageing and its determinants, the present review suffers from other limitations. The statistical power of many of the analyses was low because of the small number of study subjects and the limited contrast in the distribution of the determinants.

Our review underlies the need for large-scale prospective studies in different populations with broad range of exposures and standard definitions of ageing-related determinants and characteristics. The European Prospective Investigation into Cancer and Nutrition (26) represents one of such studies. Furthermore, the inclusion of biomarker measurements and genetic determinants in future studies would facilitate the iden-

tification of biological mechanisms underlying healthy ageing. This should be done via collaboration of clinicians, epidemiologists, sociologists, basic researchers and public health professionals.

## Keypoints

Following the increase in life expectancy, research on determinants of healthy ageing has grown in importance.

1. Lifestyle, social and genetic determinants of healthy ageing are important to study.
2. In this systematic review of the literature we identified low body mass index, avoidance of tobacco smoking and regular/heavy physical activity as determinants of healthy ageing.
3. Avoidance of alcohol drinking and of hypertension are probable determinants of healthy ageing.

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