
The exposome of healthy and accelerated aging across 40 countries

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Supplementary S1. Harmonization

Harmonization procedures were applied to the predictors of chronological age due to differences in the assessment of variables across surveys. The harmonization process is described below.

Supplementary S1.1. Cognition

Cognition was assessed using the shortened version of the Minimental State Examination (MMSE)¹ in the national surveys from Chile, Uruguay, Ecuador, Colombia, South Korea, and European countries. This version consists of 19 questions with a cutoff score of 13 points. The test included the following components: 1. Participants provide the date (one point each for day, date, month, year). 2. Recall three objects named by the interviewer (one point each). 3. Perform three actions with a piece of paper (take it with the right hand, fold it in half, place it on the lap; one point each). 4. Recall the three objects (scored as in step 2). 5. Copy a drawing (one point if correct). 6. Recall a five-number sequence (one point per correct number, up to five points). The final score is calculated using standardized metrics.

In Costa Rica and China, cognition was assessed with a five-question test, with a total score of 13 points. The components included: 1. Providing the date (one point each for day of the week, date, month, and year). 2. Remembering three objects named by the interviewer (one point each). 3. Performing three actions with a piece of paper (take it with the right hand, fold it in half, place it on the lap; one point each). 4. Recalling the three objects (scored as in step 2).

In Brazil, cognition was measured as the average of three categories: 1. orientation (providing the date, one point for each correct response: day of the week, day, month, year); 2. verbal fluency (recalling as many animals as possible within one minute); 3. word list recall (recalling words from a 10-word list). In Mexico, the approach included the average of: 1. verbal learning (learning 18 words read at 2-second intervals, repeated three times); 2. verbal fluency (recalling animals in one minute); 3. orientation (providing the date); 4. motor skills (drawing a geometric figure); 5. word list recall; 6. visual attention (matching figures to a pattern); 7. calculation (serial subtraction of 7s from 100). In Egypt, cognition was assessed through: 1. orientation (providing the date); and 2. verbal fluency (immediate and delayed word recall). In India, the Addenbrooke's Cognitive Examination (ACE)² was used, with scores harmonized by converting ACE results to MMSE scores using a conversion table. Due to differences in cognitive assessments across countries, the cognitive measure was standardized by transforming scores to a 0-10 scale, where 10 indicates the highest cognitive performance.

Supplementary S1.2. Functional ability

Functional ability was measured using a modified version of the Barthel Index³.

Chile and Uruguay: 1. Has the subject had difficulty running or jogging a mile? 2. Has the subject had difficulty walking several streets? 3. Has the subject had difficulty sitting for two hours? 4. Has the subject had difficulty getting up from a chair? 5. Has the subject had difficulty climbing several floors? 6. Has the subject had difficulty climbing a floor? 7. Has the subject had difficulty bending over? 8. Has the subject had difficulty extending the arms? 9. Has the subject had difficulty pulling or pushing a large object? 10. Has the subject had difficulty lifting or carrying a weight of 5 kg? 11. Has the subject had difficulty lifting a coin off a table? 12. Does the subject have difficulty crossing the room? 13. Does the subject have difficulty dressing? 14. Does the subject have difficulty bathing? 15. Does the subject have difficulty eating? 16. Does the subject have difficulty lying down? 17. Does the subject have difficulty using a toilet? 18. Does the subject have difficulty preparing food? 19. Does the subject have difficulty handling money? 20. Does the subject have difficulty going places? 21. Does the subject have difficulty purchasing food? 22. Does the subject have difficulty making phone calls? 23. Does the subject have difficulty performing light work? 24. Does the subject have difficulty performing heavy work? 25. Does the subject have difficulty taking medicine?

Ecuador: 1. Does the subject have difficulty running or jogging a mile or 15 blocks? 2. Does the subject have difficulty sitting for two hours? 3. Does the subject have difficulty getting up from a chair after sitting for a long time? 4. Does the subject have difficulty climbing several floors without resting? 5. Does the subject have difficulty bending, kneeling or stooping? 6. Does the subject have difficulty extending the arms above the shoulders? 7. Does the subject have difficulty pulling, pushing, or removing a large object, such as an armchair? 8. Does the subject have difficulty lifting or carrying a weight of more than 5 kilograms (10 pounds), such as a heavy shopping bag? 9. Does the subject have difficulty lifting a coin off a table? 10. Does the subject have difficulty crossing the room? 11. Does the subject have difficulty dressing (including putting shoes and socks)? 12. Does the subject have difficulty bathing (including getting in and out of the bathtub)? 13. Does the subject have difficulty eating (including cutting food, filling glasses)? 14. Does the subject have difficulty lying down or getting out of bed? 15. Does the subject have difficulty using a toilet (including sitting down and getting up)? 16. Does the subject have difficulty preparing hot food? 17. Does the subject have difficulty handling money? 18. Does the subject have difficulty going places alone? 19. Does the subject have difficulty purchasing food? 20. Does the subject have difficulty making phone calls? 21. Does the subject have difficulty performing light work? 22. Does the subject have difficulty performing heavy work? 23. Does the subject have difficulty taking medicine?

Colombia: 1. Is the subject able to eat without assistance today? 2. Is the subject able to bathe without assistance today? 3. Was the subject able to dress without assistance today? 4. Is the subject able to wash hands and face, comb his/her hair, shave or brush his/her teeth without assistance today? 5. Is the subject continent in terms of deposition? 6. Is the subject continent in terms of urination? 7. Was the subject able to use the toilet without assistance today? 8. Is the subject able to move from bed to chair? 9. Is the subject able to walk without assistance (independently)? 10. Is the subject able to go up and down stairs without assistance? 11. Is the subject able to manage his/her money? 12. Is the subject able to shop daily? 13. Is the subject able to prepare food? Is the subject able to manage his/her medications? 14. Is the subject able to use public transportation? 15. Is the subject able to use the phone? 16. Does the subject have difficulty walking 5 blocks? 17. Does the subject need assistance to walk? 18. Is the subject able to walk 3 times a week between 9 and 20 blocks? 19. Is the subject able to walk 3 times per week less than 8 blocks? Costa Rica: 1. Was the subject able to talk? 2. Does the subject have difficulty walking 20 blocks? 3. Does the subject have difficulty pushing objects? 4. Does the subject have difficulty lifting arms? 5. Does the subject have difficulty cutting toenails? 6. Does the subject have difficulty preparing meals? 7. Does the subject have difficulty managing money? 8. Does the subject have difficulty shopping? 9. Does the subject have difficulty taking meds?

Brazil: 1. Do you have any difficulty with doing your own personal hygiene? 2. Do you have any difficulty with preparing a hot meal? 3. Do you have any difficulty with showering? 4. Do you have any difficulty with dressing up? 5. In the last month, have you ever lost control of urine or feces, unintentionally? 6. Do you have any difficulty with using the bathroom? 7. Do you have any difficulty with getting in or out of bed? 8. Do you have any difficulty walking 100 meters (one block)? 9. Do you have any difficulty climbing one flight of stairs without stopping or resting?

Mexico: Due to health problems, do you have difficulty walking several blocks? 2. Due to health problems, do you have any difficulty running or jogging a kilometer? 3. Due to health problems, do you have any difficulty walking one block? 4. Due to health problems, do you have any difficulty sitting for two hours? 5. Due to health problems, do you have any difficulty getting up from a chair after being seated for a long time? 6. Due to health problems, do you have any difficulty climbing several flights of stairs without resting? 7. Due to health problems, do you have any difficulty climbing one flight of stairs without resting? 8. Due to health problems, do you have any difficulty bending over, kneeling, squatting, or crouching? 9. Due to health problems, do you have any difficulty lifting or extending your arms above your shoulders? 10. Due to health problems, do you have difficulty pulling or pushing large objects such as an armchair? 11. Due to health problems, do you have any difficulty lifting or carrying objects that weigh more than 5 kilograms, such as a heavy bag of groceries? 12. Due to health problems, do you have any difficulty picking up a one-peso coin from

the table? 13. Due to health problems, do you have difficulty dressing yourself, including putting on shoes and socks? 14. Does anyone help you dress? 15. Do you have difficulty walking across a room? 16. Do you have difficulty bathing in a tub or shower? 17. Do you have difficulty eating, for example cutting your food? 18. Do you have difficulty lying down and getting out of bed? 19. Do you have difficulty using the toilet, including sitting down and getting up or squatting?

European countries: Do you have difficulty walking 100 meters? 2. Do you have difficulty sitting for about two hours? 3. Do you have difficulty getting up from a chair after sitting for long periods? 4. Do you have difficulty climbing several flights of stairs without resting? 5. Do you have difficulty climbing one flight of stairs without resting? 6. Do you have difficulty stooping, kneeling, or crouching? 7. Do you have difficulty reaching or extending your arms above shoulder level? 8. Do you have difficulty pulling or pushing large objects like a living room chair? 9. Do you have difficulty lifting or carrying weights over 10 pounds/5 kg, like a heavy bag of groceries? 10. Do you have difficulty picking up a small coin from a table? 11. Do you have difficulty dressing, including putting on shoes and socks? 12. Do you have difficulty walking across a room? 13. Do you have difficulty bathing or showering? 14. Do you have difficulty eating, such as cutting up your food? 15. Do you have difficulty getting in or out of bed? 16. Do you have difficulty using the toilet, including getting up or down? 17. Do you have difficulty using a map to figure out how to get around in a strange place? 18. Do you have difficulty preparing a hot meal? 19. Do you have difficulty shopping for groceries? 20. Do you have difficulty making telephone calls? 21. Do you have difficulty taking medications? 22. Do you have difficulty doing work around the house or garden? 23. Do you have difficulty managing money, such as paying bills and keeping track of expenses? 24. Do you have difficulty leaving the house independently and accessing transportation services? 25. Do you have difficulty doing personal laundry?

South Korea: Do you need help with dressing? 2. Do you need help with washing your face and hair and brushing your teeth? 3. Do you need help with bathing and showering? 4. Do you need help with eating food that has been prepared? 5. Do you need help with getting in and out of bed and walking across a room? 6. Do you need help with using the toilet? 7. Do you need help with using the toilet without spilling urine? 8. Do you need help with grooming? 9. Do you need help with household chores? 10. Do you need help with preparing meals? 11. Do you need help with doing laundry? 12. Do you need help with going out nearby without using transportation? 13. Do you need help with going out that involves using transportation? 14. Do you need help with shopping at a store? 15. Do you need help with managing money? 16. Do you need help with making and taking phone calls? 17. Do you need help with taking medications?

China: 1. Does the subject require help for dressing? 2. Does the subject require help for washing face and hair and brushing teeth? 3. Does the subject require help for bathing and showering? 4. Does the subject require help for eating food that they have prepared? 5. Does the subject require help for getting in/out bed and walking across a room? 6. Does the subject require help for using the toilet? 7. Does the subject require help using the toilet without spilling out urine? 8. Does the subject require help for grooming? 9. Does the subject require help for household chores? 10. Does the subject require help for preparing meals? 11. Does the subject require help for doing the laundry? 12. Does the subject require help going near places without transportation? 13. Does the subject require help going out using transportation? 14. Does the subject required help shop? 15. Does the subject required help manage money? 16. Does the subject require help making and talking a call? 17. Does the subject required help talk? Egypt: Are you able to walk 100 meters without resting? 2. Are you able to sit for 2 hours without getting up? 3. Are you able to stand up from a chair after sitting for a long time? 4. Are you able to go up three stories? 5. Are you able to hold coins in your hand? 6. Are you able to get dressed alone? 7. Are you able to walk in the house? 8. Are you able to get a shower alone? 9. Are you able to eat alone without help? 10. Are you able to go to the bathroom without help? 11. Are you able to prepare food? 12. Are you able to go grocery shopping? 13. Are you able to call family and friends? 14. Are you able to take your own medication? 15. Are you able to do household chores?

Given the previously described differences in functional ability assessments across countries, the final score for this domain was standardized by transforming the scores to a scale ranging from 0 to 10, where 10 represents the highest level of functional ability.

Supplementary S1.3. Well-being

This predictor evaluates the level of satisfaction and well-being among participants. The questions used to assess this domain in each dataset are described below.

Chile: 1. How is your health? 2. How does your health compare to last year? 3. How does your health compare to others? 4. How is your health?

Uruguay: 1. How is your health? 2. How does your health compare to last year? 3. How does your health compare to others? 4. How is your health?

Ecuador: Would you say your health is excellent, very good, good, fair, or poor? 2. Comparing your health to a year ago (twelve months), would you say it is now better, the same, or worse than then? 3. Compared to other people your age, would you say your health is better, the same, or worse?

Colombia: Would you say your health is excellent, very good, good, fair, or poor? 2. Comparing your health to a year ago, would you say it is now better, the same, or worse than then? 3. Compared to other people your age, would you say your health is better, the same, or worse?

Costa Rica and Brazil: Would you say your health is excellent, very good, good, fair, or poor? 2. Comparing your health to a year ago, would you say it is now better, the same, or worse than then? 3. Compared to other people your age, would you say your health is better, the same, or worse? 4. Have you been satisfied with your life? 5. Did you feel that your life is empty? 6. Did you feel happy most of the time? 7. Did you feel full of energy? 8. Were you in good spirits most of the time?

Mexico: Would you say your health is excellent, very good, good, fair, or poor? 2. Comparing your health to two years ago, would you say it is now better, the same, or worse than then? 3. Compared to other people your age, would you say your health is better, the same, or worse? During the past week, have you felt depressed? 5. During the past week, have you felt happy? 6. During the past week, have you felt that you had a lot of energy?

European countries: The survey from European countries included the Quality of Life Scale (CASP), which we used as a measure of wellbeing⁴.

South Korea: 1. Are you satisfied with your health status? 2. Are you satisfied with your economic status? 3. Are you satisfied with your relationship with your spouse? 4. Are you satisfied with your relationship with your children? 5. Are you satisfied with your overall quality of life?

China: Is your self-reported quality of life very good, good, so-so, bad, very bad, or are you not able to answer?

Given the previously described differences in well-being assessments across countries, the final score for this domain was standardized by transforming the scores to a scale ranging from 0 to 10, where 10 represents the highest level of wellbeing.

Supplementary S1.4. Education

Education level was assessed using the following questions across countries:

Chile: 1. Elementary education, 2. Secondary education, 3. Primary education as a requirement, 4. Secondary education as a requirement, 5. Preparatory, 6. Normal, 7. Professional, 8. Postgraduate.

Uruguay: 1. Elementary education, 2. Secondary education, 3. Primary education as a requirement, 4. Secondary education as a requirement, 5. Preparatory, 6. Normal, 7. Professional, 8. Postgraduate. Ecuador: 1. None, 2. Literacy Center, 3. Kindergarten, 4. Elementary education, 5. Secondary education, 6. High School Cycle, 7. Postgraduate.

Colombia: 1. None, 2. Incomplete elementary education, 3. Complete elementary education, 4. Incomplete Secondary education, 5. Complete Secondary education, 6. Technician or technologist without degree, 7. Technician or technologist with degree, 8. University without degree, 9. University with degree, 10. Postgraduate without degree, 11. Postgraduate with degree.

Costa Rica: 0. None. 1. One to six years of education. 2. Seven to eleven years of education. 3. More than twelve years of education. Brazil: 1. Never studied. 2. First Grade (Elementary School). 3. Second Grade. 4. Third Grade. 5. Fourth Grade. 6. Fifth Grade. 7. Sixth Grade (Middle School). 8. Seventh Grade. 9. Eighth Grade. 10. Ninth Grade (High School). 11. Tenth Grade. 12. Eleventh/Twelfth Grade. 13. GED. 14. Some college (incomplete). 15. College complete. 16. Specialization/medical residency. 17. Master's degree. 18. Doctoral degree/PhD.

Mexico: 0. None. 1. Primary. 2. Secondary. 3. Technical or commercial career. 4. Preparatory or High School. 5. Basic teacher training. 6. Professional. 7. Postgraduate.

European countries: 0. No education. 1. Did not finish elementary school. 2. Finished elementary school (6th grade, 4th grade before the war). 3. Finished 7th or 8th grade of elementary school. 4. Completed secondary education. 5. Completed basic professional school. 6. Completed general secondary school without graduation certificate. 7. Technical high school without graduation diploma. 8. Specialized high school without secondary school certification. 9. General high school with graduation certificate. 10. Technical high school with graduation certificate. 11. Specialized high school with graduation certificate.

South Korea: 1. Elementary school. 2. Middle school. 3. High school. 4. College/ University.

China: 1. Elementary school, 2. Middle school, 3. High School, 4. College/University.

India: Years of education. Egypt: 0. No education. 1. Primary education. 2. Prep education. 3. High school. 4. Medium high school. 5. Bachelor. 6. Post graduated.

Considering the differences in measurements for assessing education levels across countries, this metric was transformed and categorized into five groups: elementary school, middle school, high school, bachelor's degree, and postgraduate degrees.

Supplementary S1.5. Physical activity

Chile/Uruguay: Does the subject perform rigorous activities? Ecuador: Did the subject perform rigorous exercise or physical activity, such as sports, jogging, dancing, or heavy labor, at least three times per week, in the last 12 months? Colombia: Does the subject participate at least three times per week, in any sporting activity or exercise such as swimming, jogging, tennis, cycling, aerobics, gymnastics classes or other activities, which cause sweating or make the subject breathless? Costa Rica: In the last 12 months, did the subject exercise regularly or do other rigorous physical activities like sports, jogging, dancing, or heaving work, 3 times per week? Brazil: 1. In how many days of the last week did you perform moderate activities for at least 10 continuous minutes? 2. On the days that you perform these moderate activities for at least 10 consecutive minutes, how much time in total do you spend doing these activities per day? 3. In how many days of the last week did you perform vigorous activities for at least 10 continuous minutes? Mexico: On average over the past two years, have you exercised or done heavy physical work three times per week or more? Share dataset countries: 1. We would like to know about the type and amount of physical activity you do in your daily life. How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labor? 2. How often do you engage in activities that require a moderate

level of energy such as gardening, cleaning the car, or doing a walk? South Korea: China: Does the subject exercise regularly?

Given the different measures used across countries to track this variable, we transformed it into a categorical variable indicating whether participants engage in physical activity or not.

Supplementary S1.6. Hypertension

Chile/Uruguay: Does the subject have high blood pressure? Ecuador/Colombia: Has a doctor or nurse ever diagnosed whether the subject has hypertension? Costa Rica: During the last 2 years, did a physician tell the subject that he/she has high blood pressure (hypertension)? Brazil: Has any doctor ever told you that you have hypertension (high blood pressure)? Mexico: Has a doctor or medical staff ever told you that you have hypertension or high blood pressure? Share dataset countries: Has a doctor told you that you had high blood pressure or hypertension? South Korea: Do you have high blood pressure or hypertension, or not? China: Does the subject have hypertension? India: Do you have high blood pressure? Egypt: Do you have high blood pressure?

To normalize this variable across countries, we transformed it into a categorical variable indicating whether participants were informed of having high blood pressure or not.

Supplementary S1.7. Diabetes

Chile/Uruguay: Does the subject have diabetes? Ecuador/Colombia: Has a doctor or nurse ever diagnosed whether the subject has diabetes? Costa Rica: Does the subject have diabetes? Brazil: Has any doctor ever told you that you have diabetes (“high blood sugar”)? Mexico: Has a doctor or medical staff ever told you that you have diabetes? Share dataset countries: Has a doctor told you that you had diabetes or high blood sugar? South Korea: Do you have diabetes or high blood sugar, or not? China: Does the subject have diabetes? India: Do you have diabetes? Egypt: Do you have diabetes?

To normalize this variable across countries, we transformed it into a categorical variable indicating whether participants were informed of having high blood sugar or diabetes or not.

Supplementary S1.8. Heart Disease

Chile/Uruguay: Has the subject had a heart attack? Ecuador: Has a doctor or nurse ever diagnosed the subject with a heart attack, coronary heart disease, angina, congestive heart disease or other heart problems? Colombia: Has a doctor or nurse ever diagnosed the subject with a heart attack, pre-heart attack or other heart problems? Costa Rica: During the last 2 years has a physician told the subject that he/she has had a heart attack? Brazil: Has any doctor ever told you that you had a heart attack? Mexico: Has a doctor or medical staff ever told you that you have had a heart attack? Share dataset countries: Has a doctor told you that you had a heart attack, including myocardial infarction, coronary thrombosis, or any other heart problem, including congestive heart failure? South Korea: Do you have a heart-related disease, or not? China: Since the previous interview, has the subject been diagnosed with a heart-related disease? India: Do you have a cardiovascular disease? Egypt: Do you have a heart disease?

To normalize this variable across countries, we transformed it into a categorical variable indicating whether participants were informed of having heart disease or not.

Supplementary S1.9. Visual impairment

Chile/Uruguay: 1. How good is your distance vision? 2. How is your vision when using glasses? 3. How good is your near vision? Ecuador: How good is your vision (without glasses or contact lenses) for seeing things at a distance (like recognizing a friend across the street)? Is it excellent, very good, good, fair, or poor? 2. When using glasses or contact lenses as you normally do, would you say your distance vision is excellent, very good, good, fair, or poor? 3. How good is your vision (without glasses or contact lenses) for seeing things up close (like reading a newspaper or seeing pictures in a

magazine)? Is it excellent, very good, good, fair, or poor? Colombia: Do you wear glasses or contact lenses (or both) for distance or near vision? Costa Rica: Do you need to wear contact lenses? Brazil: 1. How do you evaluate your far vision (even when using glasses or contact lenses), this means recognizing someone that you know on the other side of the street on 65 feet or so? 2. How do you evaluate your near vision (even when using glasses or contact lenses), this means recognizing an object that is within reach or reading a newspaper? Mexico: How is your vision? Share dataset countries: 1. How good is your eyesight for seeing things at a distance, like recognizing a friend across the street? 2. How good is your eyesight for seeing things up close, like reading ordinary newspaper print? South Korea: How is your eyesight for distant objects? 2. How is your eyesight for close objects? China: Can you see the break in the circle? India: Do you have hearing impairment? Egypt: 1. If you are wearing glasses or contact lenses, how would you describe your vision? 2. With glasses or contact lenses on, how well can you see distant objects, such as recognizing someone standing across the street? 3. With glasses or contact lenses on, how well can you see close objects, such as reading a newspaper? Vision quality was averaged considering distance vision, near vision, and vision with glasses.

Visual impairment was categorized as excellent, very good, good, fair, and poor vision for the subsample excluding Egypt and India. For the analyses of all countries together, this variable was categorized as having vision problems or not.

Supplementary S1.10. Hearing impairment

Chile/Uruguay: How would you describe your hearing? Ecuador: In general, would you say your hearing is excellent, very good, good, fair, or poor (with or without a hearing aid)? Colombia: Do you have hearing problems? Costa Rica: Do you have difficulty hearing? Brazil: How do you evaluate your hearing (even when using a hearing device)? Mexico: How is your hearing ability (with a hearing aid if you normally use one)? Share dataset countries: Is your hearing excellent, very good, good, or poor? South Korea: How would you rate your hearing: very good, good, fair, bad, or very bad? China: do you have any difficulty with your hearing? India: Do you have vision impairment? Egypt: With hearing aids on, do you find it difficult to follow a conversation with background noise like a TV, radio, or children playing? 2. With hearing aids on, can you clearly hear what is being said when many people are talking at the same time? 3. With hearing aids on, can you clearly hear what one person is saying to you? 4. Do you use hearing aids?

Hearing impairment was categorized into excellent, very good, good, fair, and poor hearing for the subsample excluding Egypt and India. For the analyses of all countries together, this variable was classified as either having hearing problems or not.

Supplementary S1.11. Unhealthy weigh

Participants were asked if they had been diagnosed with obesity, underweight, or other weight-related disorders.

Supplementary S1.12. Alcohol consumption

Chile/Uruguay/Ecuador: The subjects: 1. never drinks 2. drinks less than one day per week 3. drinks 1 day a week 4. drinks 2 to 3 days a week 5. drinks 4 to 6 days a week 6. drinks every day. Colombia: he subjects: 1. never drinks 2. drinks less than one day per week 3. drinks 2 to 3 days a week 4. drinks 4 to 6 days a week 5. drinks every day. Costa Rica: 1. The subject drinks occasionally, 2. The subject drinks daily, 3. The subject drinks in special occasions only, 4. Does the subject not currently drink? 5. The subject has never drunk. Brazil: On how many days of the week do you usually drink an alcoholic beverage? Mexico: In the past three months, approximately how many days per week have you consumed an alcoholic beverage? Share dataset countries: 1. Daily or almost daily. 2. Five or six times per week. 3. Three or four times per week. 4. Once or twice per week. 5. Once or twice per month. 6. Less than once per month. 7. Not even once in the past 3 months. South Korea: 0. Normal drinking. 1. Over drinking. 2. Severe drinking (Alcoholic). China: 1. The subject never drinks, 2. The subject drinks normally, 3. The subject drinks excessively 4. The subject drinks severely (Alcoholic).

The alcohol consumption variable was categorized into four levels: never consumed, normal consumption, excessive consumption, and severe consumption.

Supplementary S1.13. Sleep problems

Chile/Uruguay: Have you experienced restless sleep? Colombia: Have you experienced difficulty sleeping? Costa Rica: Do you have insomnia? Brazil: How would you evaluate the quality of your sleep? Mexico: How often do you have difficulty falling asleep? Share dataset countries: Do you use medications for sleeping difficulties? South Korea: Have you had restless sleep during the past week? China: How is the quality of your sleep?

This variable was finally categorized into two levels, indicating whether participants have any kind of sleep problems or not.

Supplementary S2. South Africa - predictors

Supplementary S2.1. Predictors

In South Africa, a partially different survey was implemented. The following predictors were included in the models: 1. Memory (Assessed with the following questions: Do you have difficulty remembering and concentrating? Do you have difficulty communicating in your usual language, including sign language?). 2. Functional ability (Walking ability measured with the following questions: Do you have difficulty walking a kilometer or climbing a flight of steps? Do you have difficulty with self-care, such as washing or dressing?). 4. Education level (What is the highest level of education that you have successfully completed?). 5. Diabetes (Has a doctor, nurse, or other healthcare worker at a clinic, hospital, or private practice ever told you that you have/had diabetes?). 6. Hypertension (Has a doctor, nurse, or other healthcare worker at a clinic, hospital, or private practice ever told you that you have/had high blood pressure?). 7. Heart disease (Has a doctor, nurse, or other healthcare worker at a clinic, hospital, or private practice ever told you that you have/had heart disease?). 8. Visual impairment (Do you have difficulty seeing, even with glasses, if you wear them?). 9. Hearing impairment (Do you have difficulty hearing, even with a hearing aid, if you use one?). 10. Weight problems (Person's weight).

Supplementary S2.2. Longitudinal models with biobehavioral age

We examined the predictive impact of biobehavioral age in wave 1 on aspects of healthy aging (memory, functional ability, and wellbeing) in wave 2. Additionally, we assessed the role of healthy aging in wave 1 on biobehavioral age in wave 2.

Supplementary S3. Power analyses

Detecting small effect sizes (0.02) in linear regressions with 99% power required 919 participants ($\lambda=18.42$, $F=3.85$). For association metrics, detecting an OR of 1.8 with 99% power ($\alpha=0.05$, one-sided test, normal distribution, $\mu=0$, $\sigma=1$) required 202 participants (critical $z=1.65$). All countries exceeded the required sample size to achieve a power of 0.99 for association metrics (OR of 1.8, $\alpha=0.05$, one-sided test, normal distribution, $\mu=0.5$, $\sigma=1$). The only exception was the longitudinal dataset from Austria, which, with 120 participants, achieved a power of 0.91.

Supplementary S4. Permutation tests and effect sizes for BBAGs comparisons

The dataset for testing BBAGs across different incomes and regions was refined to exclude potential outliers. The first (Q1) and third quartiles (Q3) were calculated, and the interquartile range was determined as Q3 minus Q1. A filtering threshold of 10% of the interquartile range was applied to establish acceptable data limits, with the lower bound set at Q1 minus 10% of the interquartile range and the upper bound at Q3 plus 10% of the interquartile range. Data points outside these limits were flagged as potential outliers and excluded from the analysis. This method was used to minimize the effect of extreme values while retaining the dataset's primary attributes. Next, a permutation test with 100,000 permutations was conducted to assess statistical significance. Cliff's delta⁵ was used to

calculate the effect size, and a 99% confidence interval for the effect size was determined. To ensure balanced comparisons between sample pairs, subsampling was performed using 90% of the smallest sample size among the pairs. This approach was designed to enhance the reliability of the statistical analysis and provide robust effect size estimates.

Supplementary S5. Mathematical representation

Supplementary S5.1. Linear Regression

The mathematical representation of the linear regression model is:

$$Y = B_0 + B_1x + B_1x_1 + B_2x_2 + B_nx_n + \epsilon$$

where Y is the outcome variable, B_0 is the intercept, $B = [B_1, B_2, \dots, B_n]$ is the coefficients vector of the independent variables matrix $X = [x_1, x_2, \dots, x_n]$ and ϵ represents the error term. The coefficients $B_1, B_2, \dots, B_n$ are determined using the least squares method, which aims to minimize the sum of the squared differences (errors) between the observed values (actual values) and the values predicted by the model. The formulas to calculate the coefficients are:

$$B = (X^T X)^{-1} X^T Y$$

where X^T is the transpose of matrix of vector X .

Supplementary S5.2. Epidemiological association metrics

The logistic regression model is defined as:

$$\log \frac{P(Y = 1)}{P(Y = 2)} = B_0 + B^T X$$

where Y is the vector of outcomes, B_0 is the intercept term, $B^T = (B_1 + B_2, \dots, B_n)$ is the vector of regression coefficients, and $X = (x_1, x_2, \dots, x_n)$ is the covariate vector. The ORs are obtained by calculating the exponent of the model coefficients:

Supplementary S6. Effect sizes cut-offs

Multiple benchmarks exist for interpreting effect sizes, with Cohen's (1988) framework being a widely used standard. However, recent evidence suggests that Cohen's criteria, which he later disavowed, are overly stringent and lose relevance outside their original context. This has prompted extensive debate and the development of alternative frameworks. The cut-offs applied in this study are based on the findings of Gignac and Szodorai (2016)⁶ and Funder and Ozer (2019)⁷.

Supplementary Tables

Supplementary Table 1. Cross-sectional meta-analysis. Meta-analysis results with BBAGs as the exposure and cognition and functional ability as outcomes.

Study	Weight CE-RE	OR CE + RE (95% CI)	Weight CE-RE	OR CE + RE (95% CI)
Cognition			Functional ability	
China	1.11; 2.58	1.46 [1.06; 2.01]	1.13; 2.54	2.48 [1.58; 3.88]
Chile	0.02; 0.25	11.82 [1.30; 107]	0.89; 2.37	1.82 [1.1; 3.01]
Uruguay	0.02; 0.24	4.17 [0.42; 41.2]	0.72; 2.20	3.64 [2.08; 6.38]
Colombia	3.68; 2.99	2.70 [2.26; 3.21]	10.23; 3.34	2.88 [2.48; 3.35]
Ecuador	0.20; 1.38	1.52 [0.72; 3.19]	4.21; 3.16	1.49 [1.19; 1.88]
Brasil	7.37; 3.10	1.67 [1.48; 1.89]	2.94; 3.04	1.86 [1.41; 2.45]
Korea	3.85; 3.00	2.81 [2.37; 3.34]	1.52; 2.73	5.8 [3.95; 8.54]
Mexico	18.97; 3.16	2.53 [2.34; 2.73]	31.47; 3.43	2.1 [1.93; 2.29]
Egipto	0.30; 1.70	1.75 [0.95; 3.22]	0.16; 0.97	1.49 [0.46; 4.89]
India	0.50; 2.09	7.55 [4.71; 12.1]	1.01; 2.46	5.22 [3.25; 8.38]
Austria	2.11; 2.85	2.37 [1.88; 2.99]	1.97; 2.87	2.34 [1.66; 3.28]
Belgium	2.33; 2.88	1.69 [1.36; 2.1]	2.62; 3.00	2.04 [1.52; 2.73]
Czechia	3.15; 2.96	2.1 [1.74; 2.54]	2.51; 2.98	2.53 [1.88; 3.42]
Switzerland	0.91; 2.47	1.92 [1.35; 2.73]	0.55; 1.98	2.71 [1.43; 5.14]
Germany	2.03; 2.83	2.95 [2.33; 3.73]	2.24; 2.93	2.9 [2.11; 3.98]
Denmark	0.97; 2.51	1.42 [1.01; 1.99]	0.53; 1.95	5.08 [2.64; 9.76]
Estonia	4.64; 3.03	2.91 [2.49; 3.41]	5.79; 3.24	2.81 [2.3; 3.42]
Spain	5.79; 3.07	2.2 [1.92; 2.53]	1.69; 2.79	3.8 [2.64; 5.48]
France	2.90; 2.94	1.52 [1.25; 1.85]	1.22; 2.59	2.55 [1.66; 3.92]
Hungary	1.86; 2.80	3.11 [2.43; 3.97]	2.07; 2.89	2.81 [2.02; 3.91]
Italy	3.93; 3.00	3.59 [3.03; 4.25]	1.59; 2.75	6.75 [4.63; 9.84]
Netherlands	0.93; 2.49	1.49 [1.05; 2.12]	0.86; 2.34	1.29 [0.77; 2.16]
Poland	4.08; 3.01	1.53 [1.3; 1.81]	2.27; 2.93	1.88 [1.37; 2.58]
Portugal	2.01; 2.83	1.7 [1.34; 2.15]	0.46; 1.82	3.3 [1.63; 6.69]
Sweden	1.18; 2.61	2.52 [1.85; 3.43]	0.62; 2.08	3.02 [1.65; 5.53]
Slovenia	3.77; 3.00	2.46 [2.07; 2.92]	3.25; 3.08	2.51 [1.93; 3.27]
Israel	0.80; 2.40	1.57 [1.08; 2.28]	0.58; 2.02	6.96 [3.73; 13.0]
Luxembourg	1.28; 2.65	2.7 [2.01; 3.63]	0.89; 2.36	1.83 [1.1; 3.03]
Greece	2.43; 2.89	3.18 [2.56; 3.94]	1.20; 2.58	3.19 [2.07; 4.93]
Croatia	2.49; 2.90	1.94 [1.57; 2.4]	1.27; 2.62	4.05 [2.65; 6.18]
Bulgaria	1.95; 2.82	1.4 [1.1; 1.79]	1.50; 2.72	2.69 [1.83; 3.98]
Cyprus	1.18; 2.61	2.08 [1.53; 2.83]	1.02; 2.47	1.41 [0.88; 2.25]
Finland	2.62; 2.91	1.15 [0.93; 1.41]	0.47; 1.85	0.74 [0.37; 1.48]
Lithuania	2.04; 2.84	1.77 [1.4; 2.24]	1.55; 2.74	2.48 [1.69; 3.64]
Latvia	1.60; 2.75	1.26 [0.97; 1.65]	0.97; 2.43	2.65 [1.64; 4.29]
Malta	1.11; 2.58	1.65 [1.2; 2.27]	0.43; 1.76	0.98 [0.47; 2.03]
Romania	2.49; 2.90	1.98 [1.6; 2.45]	1.73; 2.80	2.7 [1.88; 3.88]
Slovak R.	1.17; 2.61	1.82 [1.33; 2.48]	0.65; 2.12	2.35 [1.31; 4.24]
Costa Rica	0.20; 1.36	7.56 [3.56; 16.0]	3.24; 3.08	1.56 [1.2; 2.03]
Global CE		2.18 [2.10; 2.55]		2.39 [2.08; 2.51]
Global RE		2.12 [1.88; 2.37]		2.56 [2.23; 2.94]
$\tau^2=0.1088$; $\chi^2=300.50$, df=38, P < 0.01; I ² =87%			$\tau^2=0.1419$; $\chi^2=177.29$, df=38, P < 0.01; I ² =79%	

CE= common effects, RE = random effects, CI = confidence interval, OR = odd ratio

Supplementary Table 2. Cross-sectional subsample meta-analysis. Meta-analysis results with BBAGs as exposure and cognition, functional ability, and wellbeing as outcomes.

Study	Weight CE-RE	OR CE + RE (95% CI)	Weight CE-RE	OR CE + RE (95% CI)	Weight CE-RE	OR CE + RE (95% CI)
	Cognition		Functional ability		Wellbeing	
China	3.26; 3.05	0.55 [0.42; 0.71]	4.51; 3.49	0.89 [0.66; 1.21]	3.54; 3.14	1.15 [0.97; 1.38]
Chile	0.28; 1.86	2.1 [0.85; 5.21]	2.05; 3.09	1.26 [0.8; 2.0]	0.87; 2.53	1.46 [1.02; 2.09]
Uruguay	0.08; 0.88	2.67 [0.48; 15.0]	1.97; 3.07	1.33 [0.83; 2.12]	1.12; 2.68	0.98 [0.71; 1.34]
Colombia	2.93; 3.03	15.4 [11.6; 20.4]	18.19; 3.8	2.91 [2.5; 3.39]	24.74; 3.37	2.43 [2.27; 2.6]
Ecuador	0.46; 2.23	1.71 [0.84; 3.49]	8.09; 3.67	0.9 [0.71; 1.13]	2.1; 2.98	1.24 [0.99; 1.56]
Brasil	14.97; 3.2	1.31 [1.15; 1.48]	6.09; 3.59	2.01 [1.54; 2.62]	9.14; 3.3	0.59 [0.52; 0.65]
Korea	9.1; 3.17	2.89 [2.46; 3.39]	3.76; 3.42	4.42 [3.16; 6.19]	3.72; 3.15	2.8 [2.36; 3.33]
Mexico	14.81; 3.2	2.46 [2.17; 2.79]	13.56; 3.76	2.24 [1.88; 2.68]	6.88; 3.27	1.82 [1.6; 2.06]
Austria	1.93; 2.92	1.7 [1.2; 2.4]	1.43; 2.84	2.19 [1.27; 3.79]	1.31; 2.77	1.74 [1.3; 2.32]
Belgium	1.81; 2.91	1.66 [1.16; 2.38]	1.83; 3.02	2.14 [1.32; 3.47]	2.25; 3.01	1.38 [1.1; 1.72]
Czechia	1.95; 2.93	1.31 [0.93; 1.85]	1.87; 3.03	2.12 [1.31; 3.41]	2.47; 3.04	1.48 [1.2; 1.83]
Switzerland	0.75; 2.53	1.44 [0.82; 2.52]	0.52; 1.92	1.72 [0.7; 4.24]	1.29; 2.76	1.64 [1.23; 2.2]
Germany	1.41; 2.82	1.77 [1.18; 2.65]	1.69; 2.96	2.19 [1.32; 3.61]	2.36; 3.02	1.79 [1.44; 2.22]
Denmark	0.67; 2.46	1.13 [0.63; 2.04]	0.44; 1.75	3.09 [1.15; 8.3]	1.48; 2.83	1.74 [1.33; 2.29]
Estonia	3.26; 3.05	2.36 [1.8; 3.08]	4.17; 3.46	2.19 [1.59; 3.02]	3.91; 3.17	1.71 [1.44; 2.02]
Spain	3.42; 3.05	1.05 [0.81; 1.37]	1.19; 2.69	1.84 [1.01; 3.34]	1.78; 2.91	1.52 [1.18; 1.95]
France	1.95; 2.93	1.76 [1.25; 2.49]	1.18; 2.68	1.33 [0.73; 2.42]	1.93; 2.95	1.46 [1.15; 1.86]
Hungary	0.62; 2.42	3.61 [1.95; 6.67]	0.85; 2.38	3.24 [1.59; 6.59]	0.85; 2.51	2.04 [1.42; 2.93]
Italy	3.96; 3.08	3.34 [2.62; 4.25]	0.81; 2.35	9.96 [4.83; 20.57]	2.47; 3.04	1.1 [0.89; 1.36]
Netherlands	1.13; 2.73	1.15 [0.73; 1.81]	0.77; 2.3	2.43 [1.16; 5.12]	1.14; 2.69	1.46 [1.06; 1.99]
Poland	2.2; 2.96	2.39 [1.73; 3.31]	1.39; 2.81	2.2 [1.27; 3.84]	2.22; 3.0	1.48 [1.19; 1.86]
Sweden	0.97; 2.67	3.47 [2.13; 5.66]	0.37; 1.59	1.71 [0.58; 5.0]	1.2; 2.72	1.8 [1.33; 2.44]
Slovenia	3.86; 3.07	2.33 [1.82; 2.98]	3.78; 3.42	2.3 [1.64; 3.22]	3.79; 3.16	2.01 [1.69; 2.38]
Israel	0.65; 2.45	4.11 [2.26; 7.45]	0.61; 2.07	5.92 [2.57; 13.65]	0.43; 2.0	0.8 [0.48; 1.33]
Luxembourg	1.13; 2.73	2.39 [1.52; 3.76]	0.67; 2.16	2.68 [1.2; 5.94]	1.23; 2.73	1.59 [1.18; 2.15]
Greece	4.96; 3.11	2.15 [1.73; 2.67]	2.45; 3.2	3.08 [2.03; 4.67]	3.14; 3.11	0.97 [0.81; 1.17]
Croatia	3.19; 3.04	2.3 [1.75; 3.01]	1.94; 3.06	4.83 [3.02; 7.72]	3.15; 3.11	1.41 [1.17; 1.7]
Bulgaria	1.5; 2.84	2.53 [1.71; 3.75]	1.13; 2.64	3.06 [1.66; 5.67]	1.02; 2.63	2.33 [1.68; 3.24]
Cyprus	1.0; 2.68	4.29 [2.65; 6.95]	0.95; 2.49	2.51 [1.28; 4.9]	0.58; 2.24	3.05 [1.97; 4.71]
Finland	1.16; 2.75	1.05 [0.67; 1.64]	0.32; 1.44	4.62 [1.45; 14.74]	1.34; 2.78	1.17 [0.88; 1.56]
Lithuania	1.89; 2.92	2.03 [1.43; 2.88]	1.79; 3.0	4.68 [2.87; 7.63]	1.55; 2.85	1.67 [1.28; 2.18]
Latvia	1.24; 2.77	1.21 [0.78; 1.86]	0.71; 2.22	2.45 [1.13; 5.33]	0.91; 2.56	2.02 [1.42; 2.86]
Malta	1.65; 2.88	1.72 [1.18; 2.5]	0.55; 1.98	3.88 [1.61; 9.33]	0.83; 2.5	1.59 [1.11; 2.3]
Slovak R.	1.27; 2.78	2.88 [1.88; 4.42]	0.83; 2.36	3.91 [1.9; 8.01]	2.49; 3.04	1.73 [1.18; 2.53]
Costa Rica	1.96; 2.93	2.31 [1.64; 3.26]	6.36; 3.61	1.73 [1.34; 2.24]	3.54; 3.14	1.2 [0.97; 1.48]
Global CE		2.05 [1.96; 2.15]		2.21 [2.07; 2.36]		1.59 [1.54; 1.65]
Global RE		2.07 [1.71; 2.50]		2.46 [2.06; 2.93]		1.53 [1.36; 1.70]
	$\tau^2=0.2877$; $\chi^2=475.87$, df=35, $p < 0.01$; $I^2=93\%$		$\tau^2=0.2047$; $\chi^2=202.38$, df=35, $p < 0.01$; $I^2=83\%$		$\tau^2=0.0947$; $\chi^2=628.75$, df=34, $p < 0.01$; $I^2=95\%$	

CE= common effects, RE = random effects, CI = confidence interval, OR = odd ratio

Supplementary Table 3. Longitudinal meta-analysis. Meta-analysis results using BBAGs from wave 1 as the exposure, with cognition, functional ability, and wellbeing from wave 2 as the outcomes.

Study	Weight CE-RE	RR CE + RE (95% CI)	Weight CE-RE	OR CE + RE (95% CI)	Weight CE-RE	RR CE + RE (95% CI)
	Cognition		Functional ability		Wellbeing	
Costa Rica	3.22; 7.36	1.24 [0.92; 1.68]	6.94; 10.17	1.77 [1.36; 2.3]	1.55; 7.2	1.14 [0.94; 1.38]
Mexico	54.7; 10.4	2.0 [1.86; 2.15]	65.7; 11.17	2.23 [2.05; 2.43]	87.03; 8.49	0.9 [0.88; 0.92]
China	6.83; 8.80	3.02 [2.45; 3.72]	16.78; 10.8	2.4 [2.03; 2.84]	1.04; 6.7	1.19 [0.94; 1.51]
Korea	11.07; 9.42	1.87 [1.59; 2.2]	3.38; 9.21	2.94 [2.01; 4.29]	2.68; 7.7	1.79 [1.54; 2.08]
Austria	0.81; 3.82	1.76 [0.96; 3.23]	0.41; 3.94	3.98 [1.34; 11.78]	0.41; 5.04	1.26 [0.86; 1.84]
Belgium	0.95; 4.24	3.11 [1.78; 5.43]	0.81; 5.79	3.49 [1.61; 7.57]	0.67; 5.99	1.29 [0.96; 1.73]
Czechia	0.86; 3.97	2.12 [1.18; 3.82]	0.62; 5.03	6.72 [2.77; 16.29]	0.74; 6.17	1.53 [1.15; 2.03]
Switzerland	1.35; 5.16	1.27 [0.8; 2.03]	0.67; 5.28	4.66 [2.0; 10.87]	0.46; 5.29	1.41 [0.99; 2.01]
Germany	0.68; 3.43	2.34 [1.21; 4.52]	0.82; 5.83	4.14 [1.92; 8.93]	0.63; 5.89	1.52 [1.12; 2.06]
Denmark	0.74; 3.62	2.56 [1.36; 4.82]	0.4; 3.9	6.41 [2.15; 19.13]	0.5; 5.46	1.72 [1.22; 2.42]
Spain	4.54; 8.09	1.73 [1.34; 2.23]	0.61; 4.98	6.85 [2.8; 16.74]	0.5; 5.46	2.19 [1.56; 3.08]
France	1.69; 5.75	2.36 [1.55; 3.59]	0.81; 5.81	2.26 [1.04; 4.89]	1.05; 6.72	1.74 [1.37; 2.2]
Greece	6.17; 8.63	1.45 [1.16; 1.81]	0.56; 4.79	3.4 [1.35; 8.58]	0.62; 5.87	1.68 [1.24; 2.28]
Italy	4.14; 7.90	2.35 [1.8; 3.07]	0.47; 4.29	9.09 [3.3; 25.05]	0.94; 6.56	2.25 [1.75; 2.89]
Poland	1.15; 4.72	2.89 [1.74; 4.8]	0.47; 4.3	6.59 [2.4; 18.12]	0.59; 5.76	1.68 [1.23; 2.3]
Sweden	1.15; 4.73	2.66 [1.6; 4.42]	0.55; 4.69	7.58 [2.96; 19.43]	0.57; 5.69	1.23 [0.89; 1.7]
Global CE		1.99 [1.89; 2.10]		2.37 [2.21; 2.54]		0.97 [0.94; 0.99]
Global RE		2.03 [1.75; 2.36]		3.57 [2.74; 4.67]		1.47 [1.29; 1.68]
$\tau^2=0.0536; \chi^2=46.98, df=15, p < 0.01; I^2=68\%$ $\tau^2=0.1640; \chi^2=45.27, df=15, p < 0.01; I^2=67\%$ $\tau^2=0.0542; \chi^2=257.59, df=15, p < 0.01; I^2=94\%$						

CE= common effects, RE = random effects, RR = relative risk, CI = confidence interval, OR = odd ratio

Supplementary Table 4. Physical Activity Assessment. BBAGs estimation incorporating work-related and leisure-time activities.

R² = 0.48, F² = 0.92, r = 0.69, RMSE = 8.05, MDE = 0.04, MAE = 6.55	
Predictors	Feature importance [SD]
Hearing impairment	0.725 [0.004]
Cognition	0.135 [0.004]
Functional ability	0.042 [0.002]
Education	0.042 [0.002]
Leisure-related physical activity	0.026 [0.002]
Hypertension	0.010 [0.001]
Female sex	0.008 [0.001]
Diabetes	0.004 [0.001]
Visual impairment	0.003 [0.0002]
Work-related physical activity	0.003[0.0002]
Heart Disease	0.002 [0.0004]

Supplementary Table 5. Impact of individual-level socioeconomic status excluding educational level on BBAGs. Socioeconomic status was calculated excluding years of education.

Predictors	Beta	t	p	d-cohen	Model p
All exposomes	-6.80	-95.47	<1e-15	0.77	<1e-15
Socioeconomic status	-3.46	-50.80	<1e-15		
Social and physical exposomes	-6.05	-85.08	<1e-15	0.69	<1e-15
Socioeconomic Status	-3.21	-46.52	<1e-15		
Sociopolitical exposomes	-4.94	-83.36	<1e-15	0.67	<1e-15
Socioeconomic Status	-3.55	-5.24	<1e-15		
Gender equality	-4.12	-78.36	<1e-15	0.63	<1e-15
Socioeconomic status	-3.06	-43.95	<1e-15		
Migration	-4.11	-52.49	<1e-15	0.42	<1e-15
Socioeconomic status	-3.12	-43.69	<1e-15		
Structural equality	-2.56	-56.52	<1e-15	0.46	<1e-15
Socioeconomic status	-3.17	-44.57	<1e-15		
Air quality	-4.14	-28.80	<1e-15	0.25	<1e-15
Socioeconomic status	-3.49	-47.25	<1e-15		
Representation	-5.27	-89.68	<1e-15	0.72	<1e-15
Socioeconomic status	-3.61	-52.44	<1e-15		
Free political parties	-6.03	-85.40	<1e-15	0.69	<1e-15
Socioeconomic status	-3.76	-54.14	<1e-15		
Inclusive suffrage	-3.47	-68.03	<1e-15	0.55	<1e-15
Socioeconomic status	-3.53	-49.99	<1e-15		
Credible elections	-5.20	-90.83	<1e-15	0.73	<1e-15
Socioeconomic status	-3.57	-51.96	<1e-15		
Local democracy	-4.55	-82.12	<1e-15	0.66	<1e-15
Socioeconomic status	-3.31	-47.79	<1e-15		

Supplementary Table 6. Impact of individual-level socioeconomic status including educational level on BBAGs. Socioeconomic status was calculated excluding years of education.

Predictors	Beta	t	p	d-cohen	Model p
All exposomes	-5.10	-85.70	<1e-15	0.48	<1e-15
Socioeconomic status	-6.02	-125.02	<1e-15		
Social and physical exposomes	-4.09	-78.23	<1e-15	0.44	<1e-15
Socioeconomic status	-5.95	-122.14	<1e-15		
Sociopolitical exposomes	-4.29	-76.24	<1e-15	0.42	<1e-15
Socioeconomic status	-6.36	-132.58	<1e-15		
Gender equality	-2.37	-66.60	<1e-15	0.37	<1e-15
Socioeconomic status	-6.06	-123.48	<1e-15		
Migration	-3.15	-54.02	<1e-15	0.30	<1e-15
Socioeconomic status	-6.38	-130.86	<1e-15		
Structural equality	-2.07	-61.34	<1e-15	0.34	<1e-15
Socioeconomic status	-6.21	-127.17	<1e-15		
Air quality	-2.55	-24.88	<1e-15	0.14	<1e-15
Socioeconomic status	-6.41	-129.23	<1e-15		
Representation	-4.32	-80.80	<1e-15	0.45	<1e-15
Socioeconomic status	-6.27	-130.88	<1e-15		
Free political parties	-4.43	-70.46	<1e-15	0.39	<1e-15
Socioeconomic status	-6.41	-133.17	<1e-15		
Inclusive suffrage	-3.32	-65.98	<1e-15	0.37	<1e-15
Socioeconomic status	-6.53	-135.99	<1e-15		
Credible elections	-4.17	-80.65	<1e-15	0.45	<1e-15
Socioeconomic status	-6.28	-130.94	<1e-15		
Local democracy	-3.86	-73.59	<1e-15	0.41	<1e-15
Socioeconomic status	-6.33	-131.54	<1e-15		

Supplementary Table 7. Comparisons of individuals classified as high and low socioeconomic status (calculated by excluding education) and living in high-income countries (HIC) and low-income countries (LIC).

GDP classification				
Group 1	Group 2	delta cliff	p value	
HIC and Low socioeconomic status	LIC and Low socioeconomic status	0.52	<1e-15	
HIC and Low socioeconomic status	LIC and High socioeconomic status	0.21	<1e-15	
HIC and Low socioeconomic status	HIC and High socioeconomic status	0.47	<1e-15	
LIC and Low socioeconomic status	LIC and High socioeconomic status	0.39	<1e-15	
LIC and Low socioeconomic status	HIC and High socioeconomic status	0.90	<1e-15	
LIC and High socioeconomic status	HIC and High socioeconomic status	0.68	<1e-15	
GNI classification				
Group 1	Group 2	delta cliff	p value	
HIC and Low socioeconomic status	HIC and High socioeconomic status	0.47	<1e-15	
HIC and Low socioeconomic status	LIC and Low socioeconomic status	0.61	<1e-15	
HIC and Low socioeconomic status	LIC and High socioeconomic status	0.02	<1e-15	
HIC and High socioeconomic status	LIC and Low socioeconomic status	0.92	<1e-15	
HIC and High socioeconomic status	LIC and High socioeconomic status	0.52	<1e-15	
LIC and Low socioeconomic status	LIC and High socioeconomic status	0.60	<1e-15	

Supplementary Table 8. Comparisons of individuals classified as high and low socioeconomic status (calculated by including education) and living in high-income countries (HIC) and low-income countries (LIC).

GDP classification		delta cliff	p value
Group 1	Group 2		
HIC and Low socioeconomic status	LIC and Low socioeconomic status	0.48	<1e-15
HIC and Low socioeconomic status	LIC and High socioeconomic status	0.22	<1e-15
HIC and Low socioeconomic status	HIC and High socioeconomic status	0.53	<1e-15
LIC and Low socioeconomic status	LIC and High socioeconomic status	0.33	<1e-15
LIC and Low socioeconomic status	HIC and High socioeconomic status	0.87	<1e-15
LIC and High socioeconomic status	HIC and High socioeconomic status	0.72	<1e-15

GNI classification		delta cliff	p value
Group 1	Group 2		
HIC and Low socioeconomic status	HIC and High socioeconomic status	0.54	<1e-15
HIC and Low socioeconomic status	LIC and Low socioeconomic status	0.55	<1e-15
HIC and Low socioeconomic status	LIC and High socioeconomic status	0.13	<1e-15
HIC and High socioeconomic status	LIC and Low socioeconomic status	0.92	<1e-15
HIC and High socioeconomic status	LIC and High socioeconomic status	0.65	<1e-15
LIC and Low socioeconomic status	LIC and High socioeconomic status	0.51	<1e-15

Supplementary Table 9. Logistic Regression Calibration Results. Model calibration tests using Hosmer–Lemeshow goodness of fit.

Outcome	p value (10 groups)	p value (50 groups)	OR	CI 99%	OR (min - max)
Functional ability	0.12	0.47	7.94	7.93-7.96	7.48-8.44
Cognition	0.65	0.37	4.57	4.56-4.58	4.26-4.89

Supplementary Table 10. Demographic information across subsample studies. Country-specific demographic data for both the cross-sectional and longitudinal supplementary studies.

Latin America (cross-sectional)			
Countries	Age (S.D)	Range	Total
Brazil	64.33 (9.49)	(51, 90)	8704 (Females = 3819)
Chile	71.02 (7.65)	(60, 90)	1054 (Females = 386)
Colombia	70.4 (7.65)	(60, 90)	22863 (Females = 9779)
Costa Rica	59.63 (3.18)	(53, 67)	2556 (Females = 1007)
Ecuador	70.0 (7.52)	(60, 90)	3673 (Females = 1877)
Mexico	62.5 (8.91)	(51, 90)	6014 (Females = 3889)
Uruguay	70.56 (6.96)	(60, 90)	1356 (Females = 507)

Europe (cross-sectional)			
Countries	Age (S.D)	Range	Total
Austria	70.92 (8.42)	(51, 90)	1323 (Females = 537)
Belgium	64.36 (10.2)	(51, 90)	1948 (Females = 887)
Bulgaria	68.43 (9.12)	(51, 90)	890 (Females = 356)
Croatia	65.35 (9.02)	(51, 90)	2520 (Females = 1133)
Cyprus	72.18 (9.36)	(51, 90)	521 (Females = 205)
Czechia	70.2 (8.03)	(51, 90)	2027 (Females = 819)
Denmark	64.86 (9.64)	(51, 90)	1325 (Females = 643)
Estonia	69.01 (10.62)	(51, 90)	3321 (Females = 1258)

Finland	68.42 (9.06)	(51, 90)	1140 (Females = 536)
France	66.21 (10.04)	(51, 90)	1539 (Females = 682)
Germany	67.81 (8.7)	(51, 90)	2140 (Females = 1005)
Greece	64.9 (10.3)	(51, 90)	2574 (Females = 1165)
Hungary	69.99 (7.34)	(53, 90)	739 (Females = 289)
Italy	64.95 (9.41)	(51, 90)	2178 (Females = 1028)
Latvia	68.46 (9.55)	(52, 90)	773 (Females = 292)
Lithuania	68.27 (10.01)	(51, 90)	1399 (Females = 522)
Luxembourg	66.57 (8.97)	(51, 90)	1123 (Females = 512)
Malta	68.35 (8.39)	(51, 90)	784 (Females = 355)
Netherlands	68.48 (8.04)	(51, 90)	979 (Females = 454)
Poland	64.51 (9.34)	(51, 90)	1734 (Females = 813)
Portugal	66.48 (8.07)	(51, 89)	194 (Females = 121)
Romania	67.03 (8.86)	(51, 90)	1248 (Females = 538)
S. Republic	63.58 (7.86)	(51, 89)	971 (Females = 442)
Slovenia	68.79 (9.19)	(51, 90)	3157 (Females = 1361)
Spain	69.99 (9.15)	(51, 90)	1478 (Females = 693)
Sweden	70.97 (8.26)	(51, 90)	1376 (Females = 675)
Switzerland	69.92 (8.39)	(51, 90)	1265 (Females = 602)
Asia (cross-sectional)			
Countries	Age (S.D)	Range	Total
China	78.62 (7.27)	(52, 90)	6622 (Females = 3483)
Israel	67.38 (9.33)	(51, 90)	403 (Females = 179)
South Korea	63.82 (9.53)	(51, 90)	8814 (Females = 3916)
Africa (longitudinal)			
Country	Age (S.D)	Range	Total
South Africa	46.69 (19.14)	(26, 91)	5431 (Females = 2285)

Results are presented as mean (SD). SD = standard deviation

Supplementary Table 11. Datasets details. Contact data and access details of the databases employed in the study.

Dataset	Countries	Contact/source	Data collection/Sampling	Ethics
National surveys on health, well-being and aging (SABE surveys)	Chile ⁷⁷	https://pubmed.ncbi.nlm.nih.gov/16053641/	Representative sample of adults aged 60+ in Santiago, selected through a three-stage cluster sampling. Stratified by geographic region. Data collected on health, quality of life, employment, and family structure	The study protocol was approved by the Institutional Review Board of the Institute of Nutrition and Food Technology of the University of Chile and the Ethical committee of the Chilean National Council for Science and Technology Research (CONICYT).
	Uruguay ⁷⁷	https://pubmed.ncbi.nlm.nih.gov/16053641/	Representative sample of adults aged 60+ in Montevideo, selected through a three-stage cluster sampling. Stratified by socioeconomic status (education, access to potable water). Data collected on health, education, employment, and living arrangements.	The study protocol was approved by the Institutional Review Board of the Institute of Nutrition and Food Technology of the University of Chile and the Ethical committee of the Chilean National Council for Science and Technology Research (CONICYT).
	Colombia ⁷⁸	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6774577	The SABE survey is a nationally representative, cross-sectional study of adults aged 60+ residing in urban and rural households. The sample was probabilistic, stratified, and multi-stage, covering six regions and large cities (Bogotá, Medellín, Cali, Barranquilla). Data collection occurred in 2015, with a total estimated population of 4,964,793.	This study was approved by the Human Ethics Committee of the Faculty of Health of Universidad del Valle (Acts No. 09-014 and 011-015) and the Bioethics Committee of the Universidad de Caldas (code CBCS-021-14).
	Ecuador ⁷⁹	https://www.ecuadorencifras.gob.ec/encuesta-de-salud-bienestar-del-adulto-mayor/	The survey targeted individuals aged 60 and older, covering both urban and rural areas in the Costa and Sierra regions. It aimed to collect comprehensive data on social, demographic, and health conditions to inform policy decisions. The sampling design was probabilistic and stratified, ensuring national representativeness. The survey was implemented between June and August 2009	Universidad San Francisco de Quito y el Instituto de Investigación en Salud y Nutrición de la USFQ
The Brazilian Longitudinal Study of Ageing (ELSI-Brazil) (2016)	Brazil ⁸⁰	https://elsi.cpqrr.fiocruz.br/	A nationally representative cohort study (2015–2016) of adults aged 50+. Using multistage stratified sampling, 9,412 participants were selected from 70 municipalities. An inverse sampling design was used to ensure the target number of interviews was reached	ELSI-Brazil was approved by the Fundação Oswaldo Cruz (FIOCRUZ) ethics committee, Minas Gerais, Brazil (protocol number 34649814.3.0000.5091). https://elsi.cpqrr.fiocruz.br/data-access/

			while minimizing nonresponse bias.	
Costa Rican Study on Longevity and Healthy Aging (CRELES)	Costa Rica ⁸¹	http://www.creles.berkeley.edu/...index.html	A nationally representative study of ~3,000 Costa Rican residents born in 1945 or earlier. Baseline data were collected in 2005, with follow-ups in 2007 and 2009. The study includes extensive health measurements, biomarkers, and mortality tracking through the National Death Index.	The Ethical Science Committee of the University of Costa Rica granted human subjects approval to CRELES (VI-763-CEC-23-04).
Encuesta Nacional sobre Salud y Envejecimiento en México (ENASEM)	Mexico	https://enasem.org/Home/..index_esp.aspx	Mexico (ENASEM) The Mexican Health and Aging Study (ENASEM) is a nationally representative longitudinal survey targeting individuals aged 50 and older. The 2021 wave followed participants from the 2018 cohort, using a probabilistic, multistage stratified sample design. The survey covered urban and rural areas, collecting data on demographics, health status, cognitive function, socioeconomic conditions, and mortality follow-ups. Interviews were conducted in person using digital devices, complemented by cognitive assessments. The sampling strategy adjusted for non-response and population estimates to ensure representativeness.	The study was approved by the Institutional Review Board or Ethics Committee of the University of Texas Medical Branch, the INEGI in Mexico, and the <i>Instituto Nacional de Salud Pública</i> (INSP) in Mexico.
Chinese Longitudinal Healthy Longevity Survey Series	China ⁸²	https://charls.pku.edu.cn/en/	The Chinese Longitudinal Healthy Longevity Survey (CLHLS) is a nationally representative study of individuals aged 65 and older. Data were collected in multiple waves, including 2011, 2014, and 2018, using a stratified, multistage sampling design. The survey covers urban and rural areas, focusing on demographics, health status, functional ability, and socioeconomic conditions.	The CLHLS study was approved by research ethics committees of Peking University (IRB00001052-13074).
Korean Longitudinal Study of Aging (KLoSA)	South Korea ⁸³	https://survey.keis.or.kr/...eng/klosa/klosa01.jsp	The Korean Longitudinal Study of Ageing is a nationally representative survey of individuals aged 45 and older. The sampling framework was based on probability proportional to size systematic sampling of the 2005 Korean Census and Housing Enumeration Districts, stratified by metropolitan areas, urban and rural regions, and apartment or non-	Korean Longitudinal Study of Aging (KLoSA) is a National public database (website: http://www.kli.re.kr/klosa/en/about/introduce.jsp). The data had ID but was anonymized. The system of identities was totally designated to protect subjects

			apartment dwellings. Age-eligible households were selected within each district, and respondents were interviewed using computer-assisted personal interviewing. The survey collects data on demographics, family structure, health, employment, income, assets, and subjective expectations.	
Survey of Health, Ageing and Retirement in Europe (SHARE)	Austria Belgium Bulgaria Croatia Cyprus Czechia Denmark Estonia Finland France Germany Greece Hungary Italy Latvia Lithuania Luxembourg Malta Netherlands Poland Portugal Romania Slovak Republic Slovenia Spain Sweden Switzerland ⁸⁴	https://www.share-eric.eu/	The Survey of Health, Ageing and Retirement in Europe is a longitudinal study that examines the health, social, and financial conditions of individuals aged 50 and older across multiple European countries. SHARE uses probability-based sampling to ensure a nationally representative sample of individuals aged 50 and older and their spouses/partners. The sampling relied on population registries, electoral rolls, or other official records. Multistage stratified sampling is often used to enhance representativeness. Households are randomly selected. SHARE collects data using Computer-Assisted Personal Interviews (CAPI) conducted face-to-face by trained interviewers.	The Ethics Council of the Max Planck Society approved the survey protocol
Egypt dataset	Egypt	mohamed-salama@aucegypt.edu	A Longitudinal Study of Egyptian Healthy Aging (AL-SEHA) is aimed at understanding the multifaceted aspects of aging in Egypt. AL-SEHA seeks to monitor the life trajectories of adults aged 50 and above, focusing on health, access to healthcare services, income, occupation, environment, and socioeconomic changes over time. It follows multistage stratified sampling.	The study received approval from the American University in Cairo's IRB (Case# 2021-2022-029) and obtained written informed consent from all participants
India dataset	India	swati.bajpai@gbhi.org	The Longitudinal Aging Study in India (LASI) follows a structured data collection and sampling process to ensure representative, high-quality data on aging, health, and retirement among older adults in India. Sampling Process	Institute Ethics committee, All India Institute of Medical Sciences, New Delhi. Ethical approval reference N° IEC-667/06.09.2019

			LASI employs a nationally representative, stratified, multistage probability sampling design. The study covers all states and union territories of India, ensuring broad geographic and socioeconomic representation. The target population includes adults aged 45 and older, along with their spouses (irrespective of age).	
South Africa dataset	South Africa	cyprian.mostert@aku.edu	The General Household Survey (GHS) in South Africa uses a two-stage, stratified sampling design to ensure national representativeness. It selects Primary Sampling Units (PSUs) based on the 2001 census and then randomly samples Dwelling Units (DUs) within them. The survey covers private households across all nine provinces and workers' hostels, excluding institutional settings like student hostels, old-age homes, hospitals, prisons, and military barracks. Trained interviewers conduct face-to-face home interviews, collecting data on household characteristics, demographics, education, employment, health, housing, and access to basic services such as water, electricity, and healthcare.	The Department of Statistics of South Africa (Stats SA), entity that implemented the GHS, declared its adherence to ethical guidelines and compliance with international standards for protecting the identities of individuals interviewed (QCC-GHS-2020) and (QCC-GHS-2021)

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