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# Life Satisfaction and Blood Pressure: A Coordinated Analysis of 16 Cohorts

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***Objective:*** Research suggests that high life satisfaction is related to better health outcomes, but its relationship with blood pressure, a key indicator of cardiovascular health, remains inconclusive. We conducted a comprehensive cross-sectional investigation of the association between life satisfaction and blood pressure. ***Method:*** We analyzed data from 16 cohorts, each including life satisfaction assessments and blood pressure measurements. We meta-analyzed associations between life satisfaction and (a) continuous levels of systolic and diastolic blood pressure and (b) presence of high blood pressure, inferred based on measured blood pressure of ≥140/90 mmHg and self-reported medication use. We also conducted parallel analyses, predicting hypertension status operationalized based solely on self-reported diagnosis and medication use, as in previous research. Finally, we examined the role of depressive symptoms in these relationships. ***Results:*** Meta-analytic results revealed no consistent association between life satisfaction and either measured blood pressure levels or the presence of high blood pressure. These associations did not differ by the type of life satisfaction measure used or by the economic conditions of the studied countries. However, when considering self-reported hypertension, higher life satisfaction was related to a lower hypertension risk, consistent with previous findings. More depressive symptoms were related to both lower measured blood pressure and a higher risk of self-reported hypertension. ***Conclusion:*** These findings highlight the importance of distinguishing between self-reported and objectively measured health outcomes when understanding and investigating the relationship between psychological and physical well-being. We discuss caveats in relying on single-day blood pressure assessments or recalled diagnoses to infer hypertension status.

***Public Significance Statement***
Although life satisfaction has been linked to better health, findings on its association with blood pressure have been mixed. In analyses of 16 cohorts, life satisfaction was not consistently associated with measured blood pressure, but people with higher life satisfaction were less likely to report having hypertension. These findings underscore the importance of distinguishing between self-reported and objectively measured health outcomes when examining links between psychological well-being and physical health.

*Keywords:* emotional well-being, mental health, cardiovascular health

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Are happier people healthier? Evidence across disciplines suggests that people who are more satisfied with their lives not only feel healthier but also are objectively healthier (Hernandez et al., 2018; Ngamaba et al., 2017; Steptoe, 2019). Such evidence has provided a basis for considering well-being interventions as promising tools for improving mental and physical health (E. Diener & Biswas-Diener, 2019; Kubzansky et al., 2023). However, studies have found that the extent to which specific facets of emotional well-being relate to physical health often depends on the type of health outcomes in question (e.g., Boehm & Kubzansky, 2012; Howell et al., 2007). For instance, despite robust evidence linking life satisfaction to a reduced risk of developing cardiovascular disease (e.g., Feller et al., 2013; Shirai et al., 2009; Sun et al., 2022), findings regarding its association with high blood pressure—a mechanism posited to underlie this association—have been mixed. Specifically, not only does life satisfaction show inconsistent longitudinal association with

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incident hypertension (e.g., Guimond et al., 2021; Kim et al., 2021), but its cross-sectional relationship with blood pressure also remains unclear.

In the present research, we focus on the cross-sectional association of life satisfaction with resting blood pressure, a critical indicator of cardiovascular health and mortality risk (He et al., 2022), and with the likelihood of having hypertension (determined based on blood pressure readings or self-report), a major risk factor for cardiovascular disease (Levy et al., 1996; Seretis et al., 2019). We evaluate the association in 16 cohorts collected from 10 countries representing various regions in Africa, America, Asia, and Europe, addressing the limited generalizability in previous studies that primarily relied on samples obtained from a narrow geographic range (e.g., Europe).

## Prior Research on the Link Between Life Satisfaction and Blood Pressure

A substantial number of studies have examined the cross-sectional association of life satisfaction with blood pressure or hypertension risk. A representative study using European data found an inverse association between life satisfaction and self-reported elevated blood pressure ("problems with high blood pressure") both at the country and individual levels (Blanchflower & Oswald, 2008). That is, countries with higher life satisfaction had fewer individuals with self-reported elevated blood pressure, and individuals higher in life satisfaction were less likely to report blood pressure problems. Another study with European data conceptually replicated this inverse association of life satisfaction with hypertension status, operationalized using either self-report of having a high blood pressure diagnosis or use of blood pressure medication (Mojon-Azzi & Sousa-Poza, 2011).

However, not all studies have shown this pattern of findings. A study of Indonesian adults found no evidence for a relationship between life satisfaction and hypertension status, ascertained via blood pressure levels measured by trained personnel (Peltzer & Pengpid, 2018). Studies of Singaporean (Yew et al., 2015) and Chinese adults (Zhang et al., 2017) also failed to find a significant association of life satisfaction with objectively measured blood pressure levels. In contrast, a recent study of U.K. citizens found a small but significant positive association between life satisfaction and systolic blood pressure (SBP; Schaare et al., 2023).

This inconsistency in the literature may stem from multiple factors, notably the differing ways in which researchers have operationalized hypertension-related endpoints (i.e., relying on self-reports of blood pressure problems, doctor's diagnoses and antihypertensive medication use, or measured blood pressure levels obtained by study staff). In fact, although these various outcomes are often treated as interchangeable indicators of hypertension, either by original investigators or by subsequent studies citing their work, they likely reflect distinct conditions. This issue was also highlighted in a meta-analysis examining the link between anxiety and hypertension (Lim et al., 2021), which found that the positive association between anxiety and hypertension disappeared when analyses were limited to studies that defined hypertension based on measured blood pressure thresholds of at least $\geq$140 or $\geq$90 mmHg, rather than, for example, self-reported diagnoses.

In addition to measurement discrepancies in the hypertension-related outcomes, studies also differ in how they assess life satisfaction (a single item vs. multi-item scale) and in cohort characteristics (e.g., national/cultural backgrounds). Regarding the latter, prior work has shown that economic conditions of countries (e.g., developing vs. developed countries) can affect the prevalence, awareness, and treatment of hypertension (Pereira et al., 2009), as well as the extent to which life satisfaction and health status are related (Ngamaba et al., 2017). This highlights the importance of considering contexts in which these relationships occur. The present research aims to address the gaps in the literature by conducting a systematic cross-national investigation into the association between life satisfaction and blood pressure.

## Overview

Our primary aim was to examine the cross-sectional association between life satisfaction and high blood pressure, while accounting for key methodological differences across studies. To do so, we analyzed data from 16 cohorts ($N > 110{,}000$) from 10 different countries. All cohorts included assessments of life satisfaction and objectively measured blood pressure obtained by trained study personnel. We first examined the average association between life satisfaction and measured blood pressure within each cohort and then meta-analyzed these associations across cohorts. We further evaluated if this association varied by (a) the type of life satisfaction measure used (i.e., single- vs. multi-item) and (b) the economic conditions of the country (i.e., developed vs. developing), characterized according to the United Nations' categorization (World Economic Situation and Prospects reports) at the time of data collection. Given prior evidence indicating that educational attainment is positively associated with life satisfaction (Tan et al., 2020) and negatively associated with blood pressure (Leng et al., 2015; Newman et al., 2023), we also accounted for educational attainment as a potential confounder, in addition to sex, age, and body mass index (BMI).

Importantly, as much of the previous work has framed findings in reference to the presence of "hypertension" (Mojon-Azzi & Sousa-Poza, 2011; Peltzer & Pengpid, 2018), we conducted additional analyses examining the relationship between life satisfaction and various hypertension-related binary variables. We use the term high blood pressure, rather than hypertension, to refer to a binary variable indicating its presence based on measured blood pressure of $\geq$140/90 mmHg and reported medication use. This was done to acknowledge its difference from the formal clinical criteria for hypertension outlined in the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7), which requires "the average of two or more properly measured, seated, BP [blood pressure] readings on each of *two or more office visits* [italics added]" (p. 28), a criterion that was not fully met in our studies.

That said, in line with previous work, we also examined associations with self-reported hypertension, defined based on a self-report of having received a diagnosis of hypertension and/or taking antihypertensive medication. While this measure has been used in previous research in relation to life satisfaction, its validity has been questioned as hypertension is often considered the "silent killer" (Kalehoff & Oparil, 2020), with many often unaware of its presence. Across studies, a significant proportion of individuals who do not report a hypertension diagnosis appear to meet the hypertension criteria based on measured blood pressure levels (Goncalves et al., 2018; Gorber et al., 2008). Accordingly, we also examined whether

life satisfaction is associated with this discrepancy itself by considering an additional outcome: high blood pressure without a diagnosis (i.e., absence of self-reported hypertension diagnosis despite measured blood pressure ≥140/90 mmHg; see Tenkorang et al., 2015).

Finally, to provide a more comprehensive understanding of the relationship between life satisfaction and blood pressure, we considered the role of depression, a facet of psychological ill-being, in the association. To this end, we evaluated depressive symptoms as a potential confounder and also examined their independent associations with blood pressure and hypertension status. These analyses were not preregistered.



## Method

### Study and Participant Criteria

We aimed to analyze population-based studies that included both a measure of life satisfaction and blood pressure data collected by trained personnel. Eligible studies could focus on subgroups of the general population (e.g., adults over 50) but were excluded if limited to patient samples. We required data sets to be publicly available or accessible upon request. In addition to studies known to the authors, we searched PubMed and PsycInfo for articles using such data sets and also searched the Interuniversity Consortium for Political and Social Research, the largest online data archive for social sciences, for relevant studies (see the online supplemental materials for search terms). Although we acknowledge the existence of smaller independently collected data sets—often based on convenience sampling—that include our key variables, we focused on large-scale, population-based studies to ensure greater confidence in methodological rigor and generalizability. We also note that our approach differs from a tranditional meta-analysis, which prioritizes comprehensive identification and synthesis of all relevant effect sizes; rather, our goal was to directly test our research question across multiple high-quality data sets.

As we were interested in evaluating the cross-sectional association, when studies included longitudinal data, we used the data from the earliest wave in which both life satisfaction and blood pressure measurements were available. Eligible participants were adults who were 18 years or older (Sarki et al., 2015) with blood pressure measured near the time life satisfaction was assessed. See Table 1 for a summary of study and cohort characteristics. Table S6 in the online supplemental materials also provides information on participants' medical history, specifically regarding diagnoses of angina, diabetes, stroke, and kidney disease. These conditions are common comorbidities of hypertension (Wong et al., 2007), and relevant data were available across data sets.

### Cohort Studies

Below, we present brief descriptions of each study. We have included references for more details in Table S1 in the online supplemental materials.

Whitehall II is a longitudinal study that began in 1985. The initial cohort consisted of 10,308 civil servants, ages 35–55, recruited from the London offices of 20 Whitehall departments between 1985 and 1988. The first wave of the study included a clinic visit and the completion of a postal questionnaire. Participants have since been invited to the research clinic every 5 years, with interim questionnaires sent between clinic visits.

English Longitudinal Study of Ageing is a longitudinal study of individuals aged 50 or older that began in 2002. The original sample included 18,813 men and women from 11,578 households, selected from a pool of respondents participating in the Health Survey for England that was conducted in 1998, 1999, and 2001. Each interview consists of a face-to-face computer-assisted personal interview (CAPI) and a self-completion questionnaire. A clinic visit is typically carried out every other wave (Waves 2, 4, 6, 8, and 9).

Midlife in the United States National Study of Health and Well-Being is a longitudinal study involving residents of the continental United States, ages 25–74. It began in 1995, recruiting over 7,000 adults, including a national sample, siblings of some respondents, and a sample of twins. Between 2004 and 2006, a follow-up survey was completed by nearly 5,900 respondents. A subset of these individuals ($N = 1,255$) also participated in the Biomarker Project. Biomarker data collection was conducted at three research centers, where various assessments, including vital signs, medication usage, and physical exams, were carried out.

National Social Life, Health, and Aging Project is a nationally representative study focusing on social relationships and healthy aging among older, community-dwelling Americans. The first data collection occurred between 2005 and 2006, involving face-to-face interviews and biomarker collection in respondents' homes. The sample consisted of 3,005 adults ages 57–85.

Health and Retirement Study is a longitudinal study that surveys a representative sample of Americans over the age of 50 every 2 years. The first data collection took place in 1992, involving in-home, face-to-face interviews with over 12,600 individuals from 7,600 households. Beginning in 2006, Health and Retirement Study incorporated enhanced face-to-face interviews, which included anthropometric measurements and blood and saliva samples.

Study on Global Ageing and Adult Health (SAGE) by the World Health Organization is a longitudinal survey of a nationally representative sample of respondents over the age of 50 (and a smaller sample of adults aged 18–49) in six lower and middle-income countries: China, Ghana, India, Mexico, Russia, and South Africa. The first data collection took place between 2007 and 2010, with a total sample size of over 40,000 respondents. Except for China and South Africa, the sample includes respondents carried over from SAGE Wave 0 (part of 2002–2004 World Health Survey). In addition to standardized questionnaires, SAGE included objective health measures such as performance tests and biomarker assessments.

The Irish Longitudinal Study on Ageing is a longitudinal study of the Irish population aged 50 or older. The first wave of the study took place in 2009–2010, recruiting over 8,500 men and women selected using random sample matching procedure. At each wave, participants complete a CAPI at home and return a self-completion questionnaire. At Waves 1, 3, and 6, participants were also invited to undergo a comprehensive health assessment either at the Health Assessment centers in Cork or Dublin or at home with a visit from a nurse.

China Health and Retirement Longitudinal Study is a longitudinal study of a nationally representative sample of Chinese individuals ages 45 or older. The first wave took place in 2011 and included over 17,500 individuals from about 10,000 households. Participants

**Table 1**
*Study and Cohort Characteristics*

| Study (data collection) | *N* | Country | Economic distinction | Sex | Age, *M* (*SD*) | Ethnic/racial/tribe background | % high BP[a] | BP monitor (measurement personnel) |
|---|---|---|---|---|---|---|---|---|
| Whitehall II (1985) | 7,625 | United Kingdom | DVED | 67% M | Med: 40–44 | 90% White, 10% non-White | 67 | Hawksley random-zero sphygmomanometer (nurse) |
| ELSA (2004) | 6,523 | England | DVED | 45% M | 66.02 (9.41) | 99% White, 1% mixed | 39 | Omron HEM-907 (nurse) |
| MIDUS Biomarker project (2004–2009) | 1,043 | United States | DVED | 46% M | 58.11 (11.62) | 93% White, 3% Black, 4% other | 33 | Finometer (nurse) |
| NSHAP (2005–2006) | 2,732 | United States | DVED | 49% M | 69.25 (7.82) | 70% White, 17% Black, 10% Hispanic, 3% other | 47 | LifeSource UA-767PVL (trained interviewer) |
| HRS (2006) | 6,349 | United States | DVED | 41% M | 67.46 (10.49) | 83% White, 13% Black, 4% other | 35 | Omron HEM-780 (trained interviewer) |
| SAGE: India (2007) | 10,773 | India | DVING | 39% M | 49.95 (16.39 | 18% Scheduled caste, 17% no caste or tribe, 7% scheduled tribe, 59% other | 23 | Boso Medistar Model S (trained interviewer) |
| SAGE: Ghana (2007–2008) | 4,887 | Ghana | DVING | 53% M | 60.04 (14.06) | 49% Akan, 10% Ga-Adangbe, 7% Ewe, 5% Gruma, 29% other | 51 | |
| SAGE: South Africa (2007–2008) | 3,838 | South Africa | DVING | 43% M | 60.25 (12.22) | 54% Black, 18% colored, 8% Indian/ Asian, 7% White, 14% other | 70 | |
| SAGE: China (2007–2010) | 13,580 | China | DVING | 48% M | 60.29 (11.82) | 98% Chinese, 2% other | 51 | |
| SAGE: Russia (2007–2010) | 4,013 | Russia | DVING[b] | 36% M | 62.3 (12.99) | 75% Russian, 12% Caucasus, 4% Volga region, 2% Ukrainian/Belorussian, 7% Other | 55 | |
| SAGE: Mexico (2009–2010) | 2,359 | Mexico | DVING | 38% M | 62.72 (13.9) | | 54 | |
| TILDA (2009–2011) | 6,092 | Ireland | DVED | 45% M | 62.32 (9.08) | | 42 | Omron M10-IT (nurse) |
| CHARLS (2011) | 11,877 | China | DVING | 47% M | 58.71 (9.57) | | 30 | Omron HEM-7200 (trained interviewer) |
| IFLS (2014–2015) | 28,545 | Indonesia | DVING | 47% M | 39.01 (14.20) | 44% Javanese, 12% Sundanese, 5% Minang, 5% Sasak, 34% other | 24 | Omron HEM-7203 (trained interviewer) |
| HSE (2016) | 4,002 | England | DVED | 44% M | Med: 50–54 | 91% White, 5% Asian, 2% Black, 2% other | 22 | Omron HEM-907 (nurse) |
| HAALSI (2018–2019) | 2,953 | South Africa | DVING | 43% M | 60.94 (12.03) | | 30 | Omron M6W (trained interviewer) |

*Note.* *N*s are based on participants with available data on our covariates (sex, age, and body mass index), life satisfaction, and hypertension status. For Whitehall and HSE, age information was provided in age groups and the median range is presented. Economic categorization (DVING = developing and DVED = developed) is based on the country's status at the time of data collection according to the United Nations (World Economic Situation and Prospects report). ELSA = English Longitudinal Study of Ageing; MIDUS = Midlife in the U.S. National Study of Health and Well-Being; NSHAP = National Social Life, Health, and Aging Project; HRS = Health and Retirement Study; SAGE = Study on Global Ageing and Adult Health; TILDA = The Irish Longitudinal Study on Ageing; CHARLS = China Health and Retirement Longitudinal Study; IFLS = Indonesian Family Life Survey; HSE = Health Survey for England; HAALSI = Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa; BP = blood pressure.

[a] High blood pressure was coded based on the current medication use and blood pressure measurement (i.e., coded as hypertensive if currently taking antihypertensive pills and/or had BP readings ≥140/90 mmHg). [b] Russia was considered economies in transitions; classifying it as DVED or DVING does not affect the moderation results.

completed a face-to-face CAPI interview and physical measurements. Physical measurements are conducted every 2 years, and blood collection occurs every two follow-up cycles. The study also obtains community-level information by surveying the people in charge of each neighborhood or village committee.

Indonesian Family Life Survey is a longitudinal study of the Indonesian population representing about 83% of the Indonesian population across 13 provinces. The first wave was conducted in 1993–1994, interviewing over 22,000 individuals from more than 7,000 households. There have been four follow-ups since then: Wave 2 in 1997–1998, Wave 3 in 2000, Wave 4 in 2007–2008, and Wave 5 in 2014–2015. The study involved completing a paper-and-pencil questionnaire (until Wave 5, when CAPI was used), physical measurements, and, in Waves 4 and 5, collection of dried blood spot data. The study also includes information about the communities where the households were located and their facilities.

Health Survey for England is an annual survey aimed at monitoring health and lifestyle trends among people living in England. The study began in 1991 and recruits about 8,000 individuals, ages 16 or older, and 2,000 children ages 0–15 each year. Participants complete an interviewer-administered interview, a self-completion questionnaire, and, if willing, a nurse visit for physical measurements and blood sample collection a few days later.

Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa is a longitudinal study focusing on the health, aging, and well-being of individuals aged 40 years and older living in rural Mpumalanga province, South Africa. The first data collection took place in 2014–2015, including more than 5,000 individuals. The study involved at-home completion of a CAPI, physical measurements, point-of-care blood tests, and collection of dried blood spots. Two subsequent waves were conducted in 2018–2019 and 2021–2022.

## Psychological Measures

### *Life Satisfaction*

Life satisfaction was assessed using a single-item measure (e.g., "I am satisfied with my life"; see Table S2 in the online supplemental materials for specific items, and Cheung & Lucas, 2014, for validity) in 12 cohorts and using five items from E. D. Diener et al.'s (1985) Satisfaction with Life Scale (e.g., "In most ways, my life is close to my ideal") in four cohorts. Items were recoded when necessary so that higher values indicate higher levels of life satisfaction. An average score was created when multiple items were used and at least one item was completed.

### *Depressive Symptoms*

Depressive symptoms were assessed using various validated versions of the Center for Epidemiological Studies Depression scale (CESD; Radloff, 1977) in eight cohorts (see Table S3 in the online supplemental materials). A single-item measure of depressive symptoms (e.g., "Have you recently been feeling unhappy and depressed?") was used in the others. In studies using the CESD, sum scores were computed only if no more than two items were missing.[1] Higher values indicating more symptoms across all studies.

## Blood Pressure Measures

### *Blood Pressure*

In all cohorts, blood pressure readings were obtained using monitors specified in Table 1. In all but three cohorts, study staff obtained three assessments, and the average of the last two systolic and diastolic blood pressure (DBP) readings was used to create a score of SBP and DBP, respectively. In the cohorts in which only two readings were obtained, the two available readings were averaged. As antihypertensive medications are expected to affect measured blood pressure levels, we included only individuals who were not currently on such medication for analyses considering measured BP.[2]

### *Presence of High Blood Pressure*

We created a categorical variable based on a combination of average blood pressure readings and self-reported medication use. Participants were coded as having high blood pressure if their blood pressure readings were $\geq$140/90 mmHg (following JNC-7 guidelines and established criteria in previous cross-country research; e.g., NCD Risk Factor Collaboration (NCD-RisC), 2019; Sarki et al., 2015, but also see recent debates around the updated threshold; e.g., Carey & Whelton, 2020; Kaul, 2020) or if they reported currently taking antihypertensive medications. Note that this variable relies partly on self-reports (medication use). We used this variable when making comparisons with results based on self-reported hypertension, but we also conducted parallel analyses in a subset of unmedicated individuals. Here, the presence of high blood pressure is defined solely based on measured blood pressure readings. This subset thus helps reduce ambiguity around medication use, which may be prescribed for other conditions, and reflects associations related to untreated, rather than uncontrolled, high blood pressure. Results were consistent with our primary analysis.

### *Self-Reported Hypertension*

Following previous research, we created a categorical variable distinguishing people with and without hypertension solely based on self-reports. Participants were coded as having hypertension if they reported having a diagnosis of hypertension and/or currently taking antihypertensive medications.

### *High Blood Pressure Without a Diagnosis*

Given concerns around the validity of a self-reported measure of hypertension status, we also created a variable capturing the discrepancy in the two hypertension variables described above. Participants were coded as having undiagnosed high blood pressure if they did not report a hypertension diagnosis, but their blood pressure readings met the $\geq$140/90 mmHg criteria (Tenkorang et al., 2015).

[1] Given various ways in which CESD score has been computed in the literature, we also conducted a parallel analysis using an item-mean imputation (Bono et al., 2007). Results were consistent with our primary analysis.

[2] We also ran alternative analyses wherein full sample was examined with blood pressure of those taking on blood pressure medication recoded as 140/90 mmHg. Results were consistent with our primary analysis.

### Covariates

Our models controlled for sex (male/female), age, and BMI (computed from measured weight and height). Based on prior work, we expected that being male, older, and having higher BMI would be associated with a higher risk of having higher blood pressure (Colafella & Denton, 2018; Gordon & Mendes, 2021; Ortega et al., 2016; Pinto, 2007). An exception is the relation between age and DBP, which does not show a linear increase with age (Pinto, 2007; Wright et al., 2011). In additional analyses, we also controlled for education. We used a variable capturing the highest level of education completed (see Table S5 in the online supplemental materials for full details), with the lowest level as the reference group. Of note, an auxiliary analysis also considered antidepressant use, which was measured slightly differently across cohorts (see Footnote 4 and Table S4 in the online supplemental materials).

## Statistical Analyses

### Data Exclusions and Cleaning

R codes for the current analyses are available at https://osf.io/syg5m/. We considered BMI $< 10$ or $>80$ as biologically implausible and set to missing (NCD Risk Factor Collaboration (NCD-RisC), 2019). We also excluded blood pressure readings with extreme values: SBP lower than 80 or greater than 260, or DBP lower than 50 or greater than 150 (Beaney et al., 2018). Participants needed at least two valid blood pressure readings to be included in the analyses. Exclusion due to missing or invalid blood pressure readings was minimal ($<3\%$).

### Primary Analyses

Our primary analysis involved examining the cross-sectional association of life satisfaction with (a) the presence of high blood pressure and (b) continuous levels of measured blood pressure. Across cohorts, we analyzed data from the full sample to answer the first question and from the subset of individuals who reported not being on hypertensive medication to address the latter. Within each cohort, we ran three primary models in which high blood pressure, SBP, or DBP was regressed on life satisfaction. All models controlled for sex, age, and BMI. For each model within each sample, we obtained an effect size of interest–log risk ratio for the binary outcome (presence of high blood pressure) and partial correlations for continuous outcomes (SBP and DBP); we fitted a Poisson model with log-link using robust standard errors (Gallis & Turner, 2019) to obtain the risk ratio. Then, we conducted a meta-analysis using the *metafor* package (Viechtbauer, 2010). As we did not expect our cohorts to come from a single population, we fitted random-effects models using restricted maximum likelihood estimation, accounting for this additional source of variance. As tests of heterogeneity, we report $Q$ and $I^2$ test results. Significant Q statistics are interpreted as suggesting heterogeneity among effect sizes and higher values of $I^2$ indicating greater heterogeneity (25%, 50%, and 75% corresponding to small, medium, and high heterogeneity; Higgins et al., 2003).

To evaluate whether measures of blood pressure are associated with standard risk factors in the expected directions, we first report the average associations between our covariates and measured blood pressure across cohorts. Then, we report results from our primary analyses—the average associations between life satisfaction and the outcomes. We present forest plots depicting the individual sample effects and meta-analytic summaries.

#### *Additional Analyses*

First, we reran all models within each cohort, additionally controlling for educational attainment. Second, we examined two potential moderators: (a) the type of scale assessing life satisfaction (single- vs. multi-item scale) and (b) the economic conditions of the studied country (developed vs. developing country; see Table 1). We fitted two separate random-effects models for samples that used a single- and multi-item scale, followed by a fixed-effects model using scale type as a moderator. A parallel set of models was run to test the moderating effect of the economic conditions.

We conducted two more sets of additional analyses that can help situate the findings within the broader literature. First, we ran the same set of analyses using self-reported hypertension and high blood pressure without a diagnosis as outcomes to understand potential discrepancy when using self-reported measures. Second, we reran our primary analyses using depressive symptoms in place of life satisfaction to gain a more comprehensive understanding of the link between psychological and physical well-being.

## Results

### Preliminary Results

Figure 1 shows that, as expected, being male, older, and having a higher BMI were significantly associated with higher SBP and DBP, except for the nonsignificant link between age and DBP. For interested readers, we also presented how the covariates are related to having high blood pressure (based on measured blood pressure) in Figure S1 in the online supplemental materials.

### Primary Results

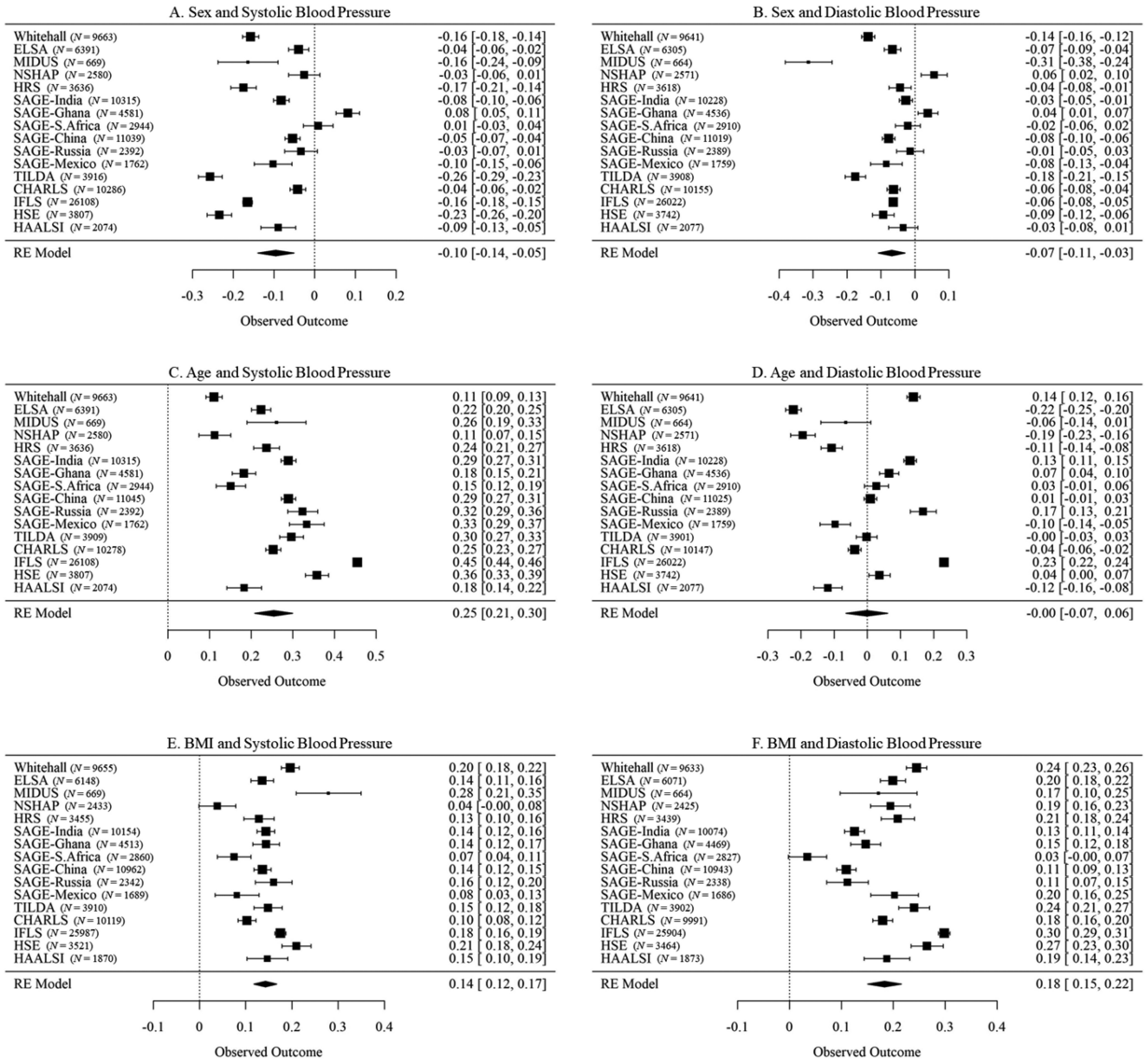
On average, life satisfaction was not associated with having high blood pressure (Figure 2A) or with measured blood pressure levels (Figure 2C and 2D). Furthermore, we observed a significant degree of heterogeneity in the link between life satisfaction and high blood pressure, $Q(15) = 31.38$, $p = .008$, $I^2 = 54.07\%$, and between life satisfaction and SBP, $Q(15) = 51.65$, $p < .001$, $I^2 = 72.76\%$. For example, for SBP, the association was positive in 10 (four of which were statistically significant) and negative in six cohorts (one of which was statistically significant). Variability across cohorts was relatively low for the link between life satisfaction and DBP $Q(15) = 16.34$, $p = .36$, $I^2 = 6.96\%$. However, the direction and strength of the associations appeared inconsistent across cohorts for all outcomes.

### Additional Analyses

Results remained consistent for the associations between life satisfaction and both the presence of high blood pressure and DBP when education was included as an additional covariate (see Figure S2 in the online supplemental materials). For SBP, the association with life satisfaction became significantly positive when controlling for education. Additionally, neither the type of life satisfaction assessment nor a country's economic conditions moderated the association between life satisfaction and the presence of

**Figure 1**

*Meta-Analytic Results for the Associations Between Covariates (Sex, Age, and BMI) and Measured Blood Pressure*



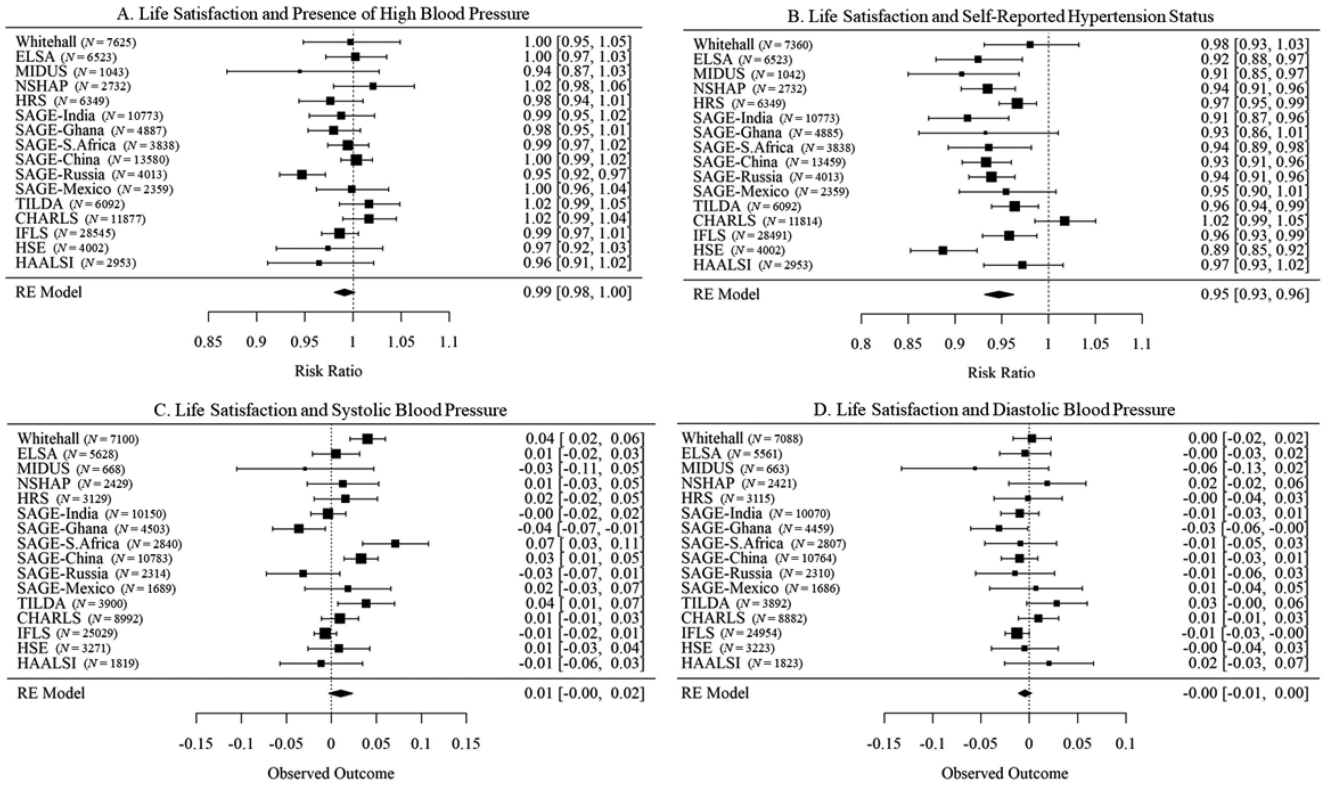

*Note.* Each panel shows associations of sex (A, B), age (C, D), and BMI (E, F) with systolic and diastolic BP, with error bars representing the 95% confidence intervals for each study's effect estimate. Sex is coded so that female (vs. male) is assigned a higher value; thus, a negative association means that being female was associated with lower BP. BMI = body mass index; ELSA = English Longitudinal Study of Ageing; MIDUS = Midlife in the United States National Study of Health and Well-Being; NSHAP = National Social Life, Health, and Aging Project; HRS = Health and Retirement Study; SAGE = Study on Global Ageing and Adult Health; TILDA = The Irish Longitudinal Study on Ageing; CHARLS = China Health and Retirement Longitudinal Study; IFLS = Indonesian Family Life Survey; HSE = Health Survey for England; HAALSI = Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa; RE = random effects; BP = blood pressure.

high blood pressure ($z = 0.43$, $p = .67$ and $z = -1.73$, $p = .08$, respectively), SBP ($z = 0.67$, $p = .51$ and $z = -1.21$, $p = .23$), or DBP ($z = 0.13$, $p = .90$ and $z = -1.61$, $p = .11$).

Considering self-reported hypertension as an outcome, we found a significant association, indicating that higher life satisfaction was associated with a lower risk of self-reported hypertension, consistent with previous work (e.g., Blanchflower & Oswald, 2008). Except for one cohort (China Health and Retirement Longitudinal Study), associations across all cohorts were in the expected direction, although the magnitude varied (Figure 2B), $Q(15) = 45.04$, $p < .001$, $I^2 = 68.94\%$. Somewhat unexpectedly, we found that higher life satisfaction was also associated with a

**Figure 2**

*Meta-Analytic Results for the Association Between Life Satisfaction and Blood Pressure*




*Note.* Each panel shows associations between life satisfaction and presence of high blood pressure (A), self-reported hypertension status (B), and systolic and diastolic blood pressure (C, D), with error bars representing the 95% confidence intervals for each study's effect estimate. ELSA = English Longitudinal Study of Ageing; MIDUS = Midlife in the United States National Study of Health and Well-Being; NSHAP = National Social Life, Health, and Aging Project; HRS = Health and Retirement Study; SAGE = Study on Global Ageing and Adult Health; TILDA = The Irish Longitudinal Study on Ageing; CHARLS = China Health and Retirement Longitudinal Study; IFLS = Indonesian Family Life Survey; HSE = Health Survey for England; HAALSI = Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa; RE = random effects.



higher risk of having high blood pressure without a diagnosis (risk ratio [RR] = 1.04, 95% CI [1.02, 1.06]; see Figure S3 in the online supplemental materials). Notably, when we took an alternative approach of predicting the presence of self-reported diagnosis or medication use in a subset of individuals with measured blood pressure of ≥140/90 mm Hg, we found that individuals with higher life satisfaction were less likely to report a diagnosis (RR = 0.95, 95% CI [0.93, 0.97]), suggesting possible unawareness (though this interpretation should be made with caution; see the Discussion section). No moderation by measurement type or country-level economic condition was found.

Finally, Figure 3 illustrates the results with the four blood pressure outcomes regressed on depressive symptoms. As with life satisfaction, depressive symptoms were unassociated with the risk of having high blood pressure, characterized according to measured blood pressure (Figure 3A), $Q(15) = 21.07$, $p = .13$, $I^2 = 29.64\%$. However, significant associations were observed with other outcomes: higher depressive symptoms were associated with lower SBP (Figure 3C), $Q(15) = 15.50$, $p = .42$, $I^2 = 20.97\%$, and DBP (Figure 3D), $Q(15) = 24.81$, $p = .05$, $I^2 = 42.26\%$, but also with a higher risk of self-reported hypertension (Figure 3B), $Q(15) = 89.29$, $p < .001$, $I^2 = 82.02\%$.[3,4] In a model including life satisfaction and depressive symptoms as simultaneous predictors of self-reported hypertension, both retained their independent effects (life satisfaction: RR = 0.97, 95% CI [0.95, 0.99]; depressive symptoms: RR = 1.06, 95% CI [1.04, 1.09]).

## Discussion

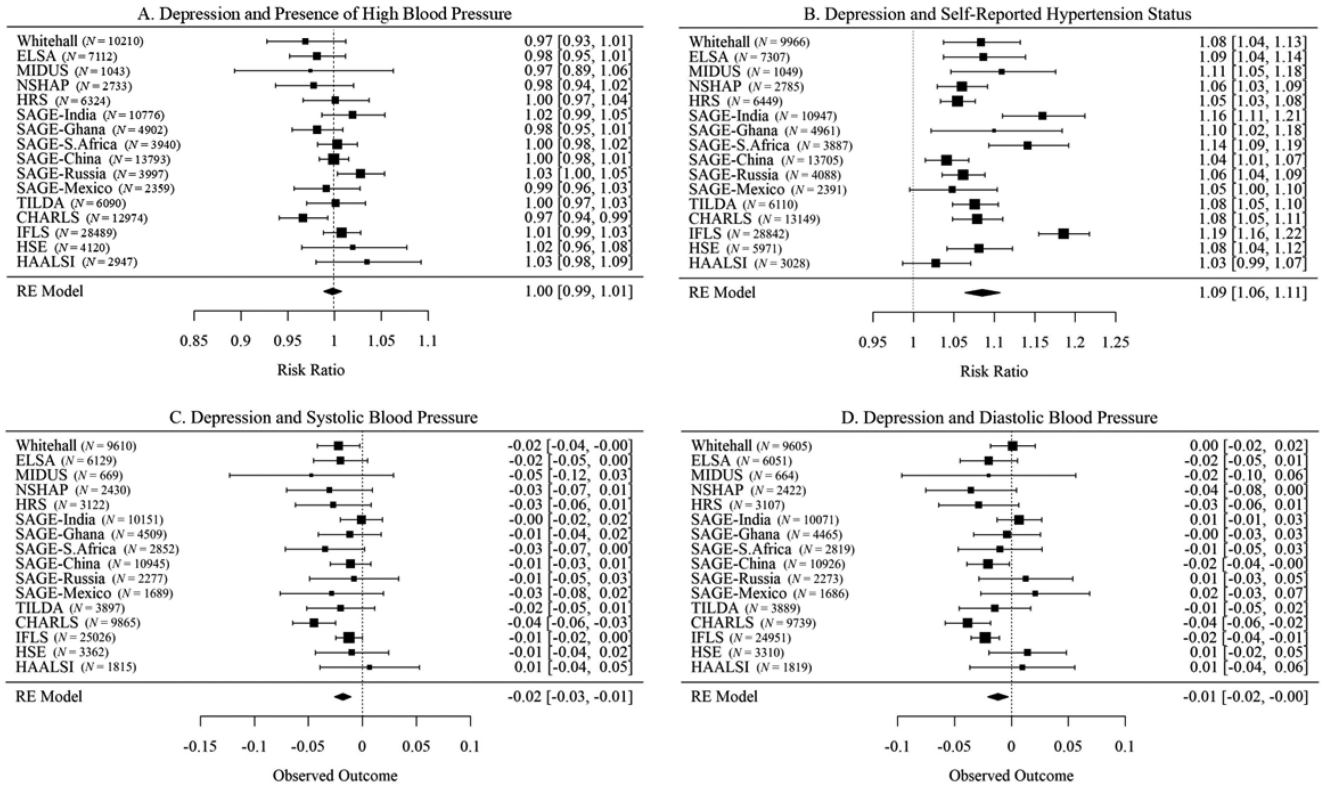
Although life satisfaction has been linked to various indicators of better physical health (Howell et al., 2007), its relationship with

[3] We also tested whether depressive-symptom scale type (single- vs. multi-item) moderated the associations. One significant moderation effect emerged, suggesting that the negative association between depressive symptoms and DBP was significant among studies using multi-item scales ($r = -.02$, $z = -5.65$, $p < .001$), but not among those using single-item measures ($r = -.00$, $z = -0.19$, $p = .85$).

[4] While data on antidepressant use was not available in all data sets, to evaluate potential confounding effects of antidepressant use on the link between depressive symptoms and self-reported hypertension, we also ran our primary model in a subset of individuals who self-reported not using antidepressants (13 data sets with available data). The results remained consistent (RR = 1.07, 95% CI [1.05, 1.09]). Please see Table S4 in the online supplemental materials for full information on how antidepressant use was assessed across cohorts.

**Figure 3**

*Meta-Analytic Results for the Association Between Depressive Symptoms and Blood Pressure*




*Note.* Each panel shows associations of depression with presence of high blood pressure (A), self-reported hypertension status (B), and systolic and diastolic blood pressure (C, D), with error bars representing the 95% confidence intervals for each study's effect estimate. ELSA = English Longitudinal Study of Ageing; MIDUS = Midlife in the United States National Study of Health and Well-Being; NSHAP = National Social Life, Health, and Aging Project; HRS = Health and Retirement Study; SAGE = Study on Global Ageing and Adult Health; TILDA = The Irish Longitudinal Study on Ageing; CHARLS = China Health and Retirement Longitudinal Study; IFLS = Indonesian Family Life Survey; HSE = Health Survey for England; HAALSI = Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa; RE = random effect.

blood pressure remains unclear. We examined the cross-sectional association between life satisfaction and blood pressure across diverse samples, considering various ways in which blood pressure, or problems thereof, has been measured. We found, on average, no reliable associations between life satisfaction and either blood pressure levels or the presence of high blood pressure as defined by measured blood pressure. These null associations did not vary by type of life satisfaction measures or economic conditions of the countries within each study. However, when considering self-reported hypertension, we observed a significant negative association, consistent with previous findings (Blanchflower & Oswald, 2008); people higher in life satisfaction were less likely to report having hypertension. When examining this discrepancy more closely, we found that higher life satisfaction was associated with having high measured blood pressure without a diagnosis of hypertension.

Taken together, our findings can be interpreted from two broad perspectives, as detailed below. One is that either the self-reported hypertension or measured blood pressure may be subject to certain biases or limitations (e.g., lack of awareness of one's condition). The other interpretation, which does not assume measurement limitations, is that both measures accurately reflect different aspects of an individual's health trajectory (e.g., high measured blood pressure without a diagnosis may reflect early signs of hypertension). In any case, our findings highlight the importance of distinguishing between self-reported and objectively measured hypertension. Using these indicators interchangeably, as is often done in the literature (Basterra-Gortari et al., 2025), may obscure meaningful phenomena or lead to misleading conclusions. Likewise, taking a seemingly more rigorous approach of drawing on multiple sources (e.g., meeting any hypertension criteria using self-reported diagnosis, medication use, and measured blood pressure; Guimond et al., 2021) requires caution; if associations vary depending on how the condition is operationalized, combining sources may undermine the precision of findings. Thus, separate analyses of self-reported and externally assessed hypertension are recommended whenever possible.

## The Possibility of Measurement Limitations

As noted, one way to interpret the differences in our findings, which vary depending on the specific outcomes examined, pertains to potential bias in the reporting of health conditions. Concerns about self-reported measures of hypertension are not new; a meta-analysis suggested a sensitivity (i.e., the probability of self-reports

correctly identifying individuals with hypertension) of 42% (Goncalves et al., 2018). A similar or even greater discrepancy between self-reported and measured data has been observed for conditions like hypercholesterolemia (Chun et al., 2016; Huang et al., 2007). Yet our work goes further to suggest that, in addition to affecting the estimation of hypertension prevalence, such limitations in self-reports may also shape our understanding of the causes, mechanisms, and consequences of hypertension. While many factors likely contribute to discrepancies between self-reported and measured data, one compelling one, particularly for conditions that are "silent" or have few discernible effects physiologically until they are far advanced, is lack of awareness. To the extent that individuals higher in life satisfaction tend to feel healthier (e.g., Kööts-Ausmees & Realo, 2015) and make fewer doctor visits (e.g., Kim et al., 2014), they may be more prone to overlook or remain unaware of their health conditions, contributing to the discrepancies between self-reported and objective health measures.

It is also possible that the discrepancy stems not from lack of awareness of the condition but from differences in how one interprets or attends to one's health. For example, individuals higher in life satisfaction may be less likely to view elevated blood pressure as concerning or may engage in less health surveillance, especially if the condition is mild or asymptomatic, whereas those lower in life satisfaction may be more vigilant or concerned about health issues, leading to greater recall or reporting of a diagnosis. Considered alongside our findings on measured blood pressure, this pattern suggests that individuals higher versus lower in life satisfaction may not necessarily differ in actual blood pressure but rather in how they perceive, recall, or report their health conditions.

Alternatively, it is also worth considering that the blood pressure measurements, rather than the self-reports, may be biased. Researchers have cautioned that clinic or office blood pressure readings could be biased upward (i.e., white coat hypertension) or downward (i.e., masked hypertension) compared to home or ambulatory blood pressure (Mancia et al., 2011). On the one hand, this interpretation fits less well with our finding that life satisfaction was related to high blood pressure without a diagnosis, which would imply more satisfied individuals are more prone to the white coat effect. On the other hand, in the only available study using ambulatory blood pressure, higher life satisfaction was indeed associated with lower SBP and DBP (Shinagawa et al., 2002), supporting the view that blood pressure measurements taken by medical or other personnel might be biased. Notably, given the sample size and limited generalizability of Shinagawa et al.'s study (54 Japanese adults), replication is needed. Ultimately, to gain better insight into our discrepant findings, larger studies examining life satisfaction in relation to both ambulatory blood pressure (often considered the gold standard) and self-reported hypertension status will be crucial.

## The Possibility of Discrepancy Capturing a Meaningful Phenomenon

We also do not want to discount the possibility that both measurements, self-reported diagnosis and measured blood pressure, were accurate, and their differing associations with life satisfaction (or the significant link between higher life satisfaction and high measured blood pressure in the absence of a diagnosis) reflect a meaningful phenomenon. A study by Schaare et al. (2023) conducted with a large U.K. cohort may help contextualize this possibility. They found that higher SBP was associated with lower depression at baseline, and this association was significantly stronger among individuals who later developed hypertension (assessed via self-report 10 years later). This led to speculation that, for those at elevated risk of hypertension, acute increases in blood pressure might be accompanied by higher well-being. This perspective is grounded in the learned hypertension model (Dworkin, 1988; Rau & Elbert, 2001), which posits that the stress- and pain-relieving effects of baroreceptor stimulation can reinforce such elevations, such that, over time, blood pressure increases become a conditioned coping response, ultimately contributing to the development of hypertension. Notably, this study did not find the same moderation pattern for the well-being variable (satisfaction across life domains); the positive baseline association between SBP and well-being did not differ by later hypertension status.

To some extent, our findings are conceptually compatible with Schaare et al.'s (2023) interpretation. In our data, higher depressive symptom levels were associated with a higher risk of self-reported hypertension, but also with lower measured blood pressure. In the same vein, high life satisfaction showed a significant association with a lower risk of self-reported hypertension but, if anything, a positive association with measured SBP (in a model additionally adjusting for education). One way to understand these seemingly paradoxical cross-sectional patterns is that they capture a snapshot of a longer trajectory of physiological and psychological adaptation among individuals who may later develop hypertension; high blood pressure may co-occur with reports of higher well-being due to the temporary stress-relieving effects of baroreceptor-mediated increases in blood pressure. Tonic elevations in blood pressure have also been associated with reduced sensitivity to physical (Makovac et al., 2020) and social pain (Inagaki & Gianaros, 2024), suggesting that elevated BP may have broad dampening effects that contribute to greater well-being. Clearly, this interpretation is speculative, and longitudinal research will be essential for testing this possibility directly. In doing so, the potential role of unmeasured confounders will also need to be carefully considered.

## Limitations and Strengths

Given that our analyses were cross-sectional, they cannot speak to mechanistic pathways or determine the directionality between life satisfaction or depressive symptoms and blood pressure. The few longitudinal studies in this area have yielded inconsistent findings. For depression, one study found that baseline depression predicted lower blood pressure at the follow-up, adjusting for baseline blood pressure readings (An et al., 2023), whereas other studies have found no significant association of depression with changes in blood pressure (Shinn et al., 2001) or incidence of hypertension (when adjusting for various confounders; Jackson et al., 2016). Fewer longitudinal studies have examined the link between life satisfaction and blood pressure, but one of the aforementioned studies found that higher baseline life satisfaction was associated with higher subsequent SBP (An et al., 2023), though this effect did not hold when depression was included in the model. A few studies have explored associations in the opposite direction, showing that higher SBP predicts lower depressive symptoms at follow-up

(Herrmann-Lingen et al., 2018; Schaare et al., 2023). Future longitudinal research will be crucial for assessing directionality in these relationships.

Furthermore, our cohorts primarily consisted of older adults, limiting our ability to examine potential age-dependent associations. This is particularly an issue in developed countries where prevalence of hypertension in older adulthood tends to be very high (e.g., 70% of U.S. adults over age 70 have hypertension; Oliveros et al., 2020), which can make it challenging to identify risk factors. Additionally, we focused only on overall life satisfaction, but domain-specific life satisfaction may play different roles (Nakamura et al., 2022). Likewise, our data sets were not well suited to examine whether different facets of depressive symptoms (e.g., somatic symptoms vs. lack of positive affect; Luppino et al., 2011; Stroup-Benham et al., 2000) have distinct associations with blood pressure, an important question for future research. Using multi-item measures of depressive symptoms is also advisable as the association with DBP differed depending on how depressive symptoms were assessed; a negative association was statistically significant only when multi-item scales were used (see Footnote 3), underscoring the need for measures that can more fully capture the experience of depressive symptoms. Finally, while our focus was on high blood pressure, a more comprehensive examination (e.g., using an outcome-wide approach; VanderWeele, 2017) of the link between life satisfaction and multiple health outcomes could elucidate whether the observed associations, including the differing effects for self-reported versus measured data, are specific to high blood pressure or reflect a more general pattern of differences in actual health status, diagnostic history, or self-reporting behavior.

Nevertheless, our study also has multiple strengths: we examined a large number of cohorts from diverse regions of the world to ensure robust and generalizable findings. We utilized both measured blood pressure and self-reported hypertension to mirror various operationalizations of blood pressure problems or hypertension commonly used in the literature. Through a coordinated data analysis in which each sample was analyzed using multiple outcomes, we systematically examined differences in the association across varying ways of operationalizing hypertension status, an approach that differs from typical meta-analyses, which often rely on sensitivity analyses within limited subsamples (Lim et al., 2021). By examining both life satisfaction and depressive symptoms, we provided a more comprehensive understanding of the mind–body connection. Overall, with the growing importance of nonpharmaceutical preventive strategies for hypertension, exploring psychological factors linked to hypertension is informative (Levine et al., 2021), and our rigorous investigation contributes valuable insights in this area.

To conclude, our cross-national investigation showed that life satisfaction was more strongly associated with self-reported hypertension than measured (high) blood pressure, suggesting caution in interpreting previous findings. In the broader context of understanding the mechanisms driving the long-term health benefits of life satisfaction, our findings do not provide strong evidence for the role of blood pressure. More definitive longitudinal or experimental work is needed, and other biobehavioral pathways clearly warrant attention.



## Resumen

***Objetivo:*** Las investigaciones sugieren que una alta satisfacción vital se relaciona con mejores resultados de salud, pero su relación con la presión arterial, un indicador clave de la salud cardiovascular, sigue sin ser concluyente. Realizamos un estudio comprehensivo exhaustivo sobre la asociación entre la satisfacción vital y la presión arterial. ***Métodos:*** Analizamos datos de 16 cohortes, cada una con evaluaciones de satisfacción vital y mediciones de presión arterial. Realizamos un metaanálisis de las asociaciones entre la satisfacción vital y (a) niveles continuos de presión arterial sistólica y diastólica, y (b) presencia de hipertensión arterial, inferida a partir de una presión arterial $\geq$140/90 mmHg y el uso de medicamentos autodeclarados. También realizamos análisis paralelos, prediciendo el estado de hipertensión operacionalizado únicamente a partir del diagnóstico autodeclarado y el uso de medicamentos, como en investigaciones previas. Finalmente, examinamos el papel de los síntomas depresivos en estas relaciones. ***Resultados:*** Los resultados del metaanálisis no revelaron una asociación consistente entre la satisfacción vital y los niveles de presión arterial medidos o la presencia de hipertensión arterial. Estas asociaciones no difirieron según el tipo de medida de satisfacción vital utilizada ni las condiciones económicas de los países estudiados. Sin embargo, al considerar la hipertensión autodeclarada, una mayor satisfacción vital se relacionó con un menor riesgo de hipertensión, consistente con hallazgos previos. Un mayor número de síntomas depresivos se relacionó tanto con una presión arterial medida más baja como con un mayor riesgo de hipertensión autodeclarada. ***Conclusiones:*** Estos hallazgos resaltan la importancia de distinguir entre los resultados de salud autodeclarados y los medidos objetivamente al comprender e investigar la relación entre el bienestar psicológico y físico. Se discuten las advertencias al basarse en las mediciones de presión arterial de un solo día o en los diagnósticos recordados para inferir el estado de hipertensión.

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