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Effects of workplace bullying on cardiovascular health: A prospective cohort study of the Gutenberg Health Study with a ten-year follow-up

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Objectives Evidence on long-term cardiovascular effects of workplace bullying is limited. We investigated prospectively the association between workplace bullying and the ten-year incidence of cardiovascular disease (CVD) and hypertension.

Methods In a cohort of 4137 employees (<65 years) from the Gutenberg Health Study (Mainz/Mainz-Bingen, Germany), workplace bullying at baseline (2007–2012) was assessed using a single- and five-item instruments. Incident CVD and hypertension at the ten-year follow-up (2017–2022) were clinically verified. Cox models were used for CVD, and robust Poisson regression for hypertension, adjusting for sex, age, and socioeconomic status (SES). Analyses were sex-stratified and considered exposure trajectories.

Results Bullying prevalence was 15.3% (single item) and 19.3% (five items). For incident CVD, hazard ratios (HR) were 1.08 [95% confidence interval (CI) 0.74–1.59] using the single-item, and 1.28 (95% CI 0.95–1.72) using the five-item instrument. Participants reporting bullying at baseline and five-year follow-up had the highest CVD risk (HR 2.44, 95% CI 1.09–5.44). No association was observed with incident hypertension (single-item: RR 1.04, 95% CI 0.84–1.28, five-item: RR 0.94, 95% CI 0.78–1.13).

Conclusions Findings indicate an increased CVD risk when repeated experiences of workplace bullying were reported. No clear elevation of CVD risk was observed when workplace bullying was only considered once at baseline. No evidence was found for elevated hypertension risk. Workplace bullying may represent a relevant psychosocial factor in cardiovascular prevention, underscoring the need for further longitudinal and intervention studies.

Key terms cardiovascular disease; hypertension; longitudinal study; mobbing; occupational health; workplace bullying.

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Workplace bullying is a global public health issue with serious consequences for both mental and physical health. Data from the Global Burden of Disease study shows that bullying victimization across contexts such as school, workplace, or online contributes to the global burden of disease (1). In 2019, bullying accounted for 2.03 million (95% CI 0.59–4.42 million) disability-adjusted life years (DALY) due to anxiety disorders and 1.71 million DALY [95% confidence interval (CI) 0.35–4.00] due to major depressive disorders, where DALY represent the sum of years lived with disability and years of life lost due to a specific disease. Workplace bullying is further associated with substantial productivity losses (2).

Prevalence estimates of workplace bullying vary considerably, from around 7% in the general working population (3, 4) to more than 26% in highly exposed professions such as healthcare and public service (5–7). Prevalence further depends strongly on regional, professional, and cultural factors (5, 6). Risk factors for workplace bullying are complex and span multiple domains: sociodemographic (eg, sex, age, marital status, migrant status, socioeconomic status), psychosocial (eg, personality traits), and work organizational level (eg, flexible work, role conflict, role ambiguity, monotonous or rotating tasks, high demands, pressure of work, and unclarity of duties), whereby the latter show the most consistent associations with workplace bullying risk (3, 8).

Löbner et al. developed a definition of workplace bullying based on a comprehensive mixed-methods approach (3). They describe it as a process occurring in all directions (top-down, horizontal, bottom-up), regardless of power relations, and characterized by recurrent and persistent negative or detrimental behaviors directed at an individual, which are perceived as unwanted and evoke feelings of defenselessness or helplessness. Such behaviors include, but are not limited to, hostility, harassment, exclusion, victimization, or humiliation, and can lead to work-related and health-related impairments.

Most research on the health impact of workplace bullying has focused on mental health outcomes, particularly depression, anxiety disorders, burnout, and suicidal thoughts or behavior (9–13). Some studies also addressed physical health issues such as sleep disorders, headaches, gastrointestinal problems, weight gain, and type 2 diabetes (9, 14, 15).

Evidence on cardiovascular consequences is scarce. By comparison, several systematic reviews have established cardiovascular risks of other psychosocial work exposures, such as job strain, long working hours, job insecurity, or effort-reward imbalance (16, 17). Only a handful of observational studies suggest an increased risk of cardiovascular disease among bullied employees (18–23). Of these studies, only one had a follow-up period of more than five years (12.4 years) (23), which allowed the long-term consequences of workplace bullying on cardiovascular health to be investigated. Although the prevalence of workplace bullying differs by sex, with higher prevalence reported among women (3), only two studies provided sex-stratified risk estimates (21, 23). Furthermore, evidence on the cardiovascular consequences of different workplace bullying trajectories over time remains limited. Only one study measured workplace bullying not only at baseline but also two years later, aiming to investigate the effect of prolonged workplace bullying on the onset of cardiovascular diseases (20). However, cardiovascular diseases were assessed at the same time point as the second measurement of workplace bullying, precluding the assessment of the effect of prolonged workplace bullying on incident cardiovascular diseases.

One cohort study had the same study population as the present investigation, but was based on the 5-year follow-up data from the Gutenberg Health Study (GHS) (21). The present study extends this work by leveraging the 10-year follow-up, allowing for the assessment of whether workplace bullying increases the risk of cardiovascular diseases and hypertension over a longer period.

To our knowledge, this long-term perspective has not previously been investigated in a German employee sample. As it has been shown that workplace bullying prevalence varies across different geographical regions (5), as may its perception and responses to it (6), we aimed to investigate the associations between workplace bullying and incident cardiovascular diseases (CVD) and hypertension in a German sample of employees over a 10-year follow-up period. In particular, we considered different workplace bullying trajectories over time and examined whether the associations differed by sex. Thus, our study extends the existing evidence with regard to workplace bullying trajectories, sex-specific cardiovascular consequences, a longer follow-up period, and geographical context.

Methods

Reporting adhered to the STROBE guideline for cohort studies (24).

Design

We used data from the 10-year follow-up of the Gutenberg Health Study (GHS), a population-based, single-center, prospective cohort study conducted in the Rhine-Main region of Germany, which was established to refine the prediction of risk factors across several major disease groups (25). All study procedures followed the

standards of Good Clinical Practice and Good Epidemiological Practice (26), were conducted in line with the Declaration of Helsinki, and met the legal requirements of the German Federal Data Protection Act. The study protocol received approval from the Ethics Committee of the Rhineland-Palatinate Chamber of Physicians, and the Data Protection Officer of the Johannes Gutenberg University Mainz reviewed and confirmed the data protection measures (reference number: 837.020.07(5555)). Prior to participation, all individuals provided written informed consent.

Participants

For the baseline assessment, a random sample of 35 008 inhabitants of Mainz and the adjacent district of Mainz-Bingen was drawn from local population registries. The sampling frame covered women and men aged 35–74 years (total target population: 210 867 individuals) and was stratified by age group, sex, and place of residence. Between 2007 and 2012, 15,010 persons took part in the baseline examination, corresponding to a response of 53% (27).

Individuals who were unable to attend the study center for physical or cognitive reasons, or who lacked sufficient German language proficiency, were generally not eligible for participation. For this analysis, we excluded individuals with missing baseline data on workplace bullying, those not employed at baseline, those aged 65 years or older at baseline, and those with the respective outcome (CVD or hypertension) before or at baseline.

Measures

Bullying measure. Two instruments were used to measure workplace bullying at baseline: a single-item and a five-item instrument. These were included in the German version of the Copenhagen Psychosocial Questionnaire (COPSOQ) (28), which was given to half of the employed participants in computer-assisted personal interviews at baseline and at follow-ups. The single-item instrument was used at both the baseline and the follow-up assessments, whereas the five-item instrument was only used at the baseline assessment.

Single-item bullying instrument. The single-item instrument by Garthus-Niegel et al. (29) posed the following question: "How often do you feel unjustly criticized, bullied or shown up in front of others by your colleagues and your superior?". Response options were "always", "often", "sometimes", "seldom", and "never". The variable "bullying" was dichotomized into 0=no bullying ("seldom" or "never") and 1=bullying ("always", "often", or "sometimes").

Five-item bullying instrument. The five-item instrument was based on items from the "Leymann Inventory of Psychological Terror" (30) and was adapted for the COPSOQ to maximize sensitivity [see (29) for further details]. The items capture key behaviors related to bullying, including intentionally interrupting someone during oral contributions (item 1), receiving no response when trying to speak to someone (item 2), being blamed for others' mistakes or general operational problems (item 3), having important influential or working tasks withdrawn (item 4), and experiencing sexual harassment (item 5).

The five-item bullying construct was dichotomized if at least three items were answered. If an item was confirmed, the participant was asked to specify how frequently it occurred: "daily/almost daily", "at least one time per week", "at least one time per month", "less than one time per month", or "never". Bullying was present if participants reported experiencing at least one out of the five items at least one time per week.

Trajectories of workplace bullying. For incident CVD, the influence of workplace bullying trajectories was examined using the single-item instrument. Participants who experienced a CVD event between baseline and the 5-year follow-up, as well as those with missing workplace bullying data at the 5-year follow-up were excluded. Based on responses at baseline (t_0) and the five-year follow-up (t_1), participants were classified into four trajectories: no bullying at t_0 and t_1 (reference category), bullying cessation (bullying at t_0, but not at t_1), onset bullying (no bullying at t_0, but at t_1), and persistent bullying (bullying at t_0 and t_1).

Measurement of cardiovascular outcomes. The primary outcome of interest was the 10-year incidence of acute myocardial infarct (ICD-10: I21), coronary artery disease (ICD-10: I25.1), sudden cardiac death (ICD-10: I46), cerebral infarction/ischemic stroke (ICD-10: I63), chronic heart failure (ICD-10: I50, I11.0, I13.0, I13.2), atrial fibrillation (ICD-10: I48), and peripheral artery disease (ICD-10: I73.9) during the 10-year follow-up period. ICD-10 codes and their dates of first occurrence after the baseline period were identified through hospital and physician records as well as death certificates. All of these were grouped as "incident case of CVD" and analyzed together. All events were validated and confirmed by an expert panel.

Hypertension (ICD-10: I10) at the 10-year follow-up was diagnosed if anti-hypertensive drugs were taken or if a mean systolic blood pressure of at least 140 mmHg or a mean diastolic blood pressure of at least 90 mmHg was measured in the second and third standardized measurements after eight and eleven minutes of rest.

Participants diagnosed with CVD or hypertension

at baseline were excluded from the respective outcome analyses. CVD events occurring before or at baseline were identified using the recorded dates of first occurrence in hospital and physician records. Hypertension was also assessed at baseline, as described above.

Statistical analysis

To assess the crude associations between workplace bullying at baseline and the 10-year incidence of CVD (figure 1 a), we calculated unadjusted incidence rate ratios (with 95% confidence intervals) based on the number of incident cases, censored events, and person-years at risk. Person-years were calculated from the baseline examination to first occurrence of a CVD event, loss-to follow-up, end of follow-up, or death, whatever came first. To account for confounders, we further estimated hazard ratios (HR) using Cox proportional hazards regression, treating deaths from non-CVD causes as censored observations. Time-to-event was defined as the number of years from baseline participation to the first occurrence of a CVD event, with participants who discontinued participation for reasons unrelated to CVD being censored. In a sensitivity analysis, we additionally examined incident arterial ischemic CVD (figure 1 a), excluding atrial fibrillation and chronic heart failure from the composite definition, to focus on a more pathophysiologically homogeneous outcome group primarily related to atherosclerotic and thrombotic processes. The risk of incident hypertension associated with workplace bullying at baseline (figure 1 a) was assessed by estimating relative risks (RRs) using robust Poisson regression, also adjusting for confounders.

For the workplace bullying trajectories analysis (figure 1 b), only participants who were free of CVD at the 5-year follow-up and remained under observation until the 10-year follow-up were included. Those with CVD occurring prior to or within the first five years were excluded from the analyses, to ensure temporality. In figure 1, the temporal relationships in the association analyses between workplace bullying exposures and CVD outcomes are shown.

For the main analysis, we applied an a priori causal definition of confounding and included only variables that were common causes of both the exposure and the outcome, namely sex, age, and socioeconomic status (SES) (31). SES was operationalized through a composite index incorporating school and vocational education, occupational position, and income (32–34). Model 1 was unadjusted; Model 2 was adjusted for sex and age; Model 3 further adjusted for SES to assess its independent contribution beyond Model 2. In additional models, we further adjusted for lifestyle factors [smoking status, alcohol consumption, waist-to-height ratio (WHtR), and physical activity (Model 4)] and psychological factors [depression, Type D personality, and anxiety disorder (Model 5)].

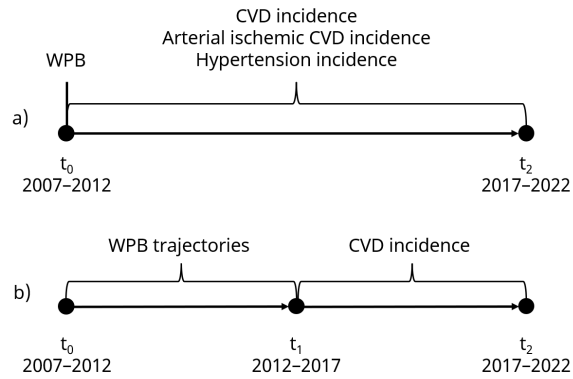


Figure 1. Temporal relationships in the association analyses between workplace bullying (WPB) exposures and cardiovascular disease (CVD) outcomes. [t_0=baseline; t^1=5-year follow-up; t^2=10-year follow-up.] (a) Exposure of WPB measured at baseline. Incidence of CVD, arterial ischemic disease, or hypertension measured during baseline and the 10-year follow-up (exclusion of CVD, arterial ischemic disease, or hypertension cases that occurred at baseline and during baseline and the 10-year follow-up). (b) WPB trajectories determined measuring WPB during baseline and at the 5-year follow-up. CVD incidence measured during the 5- and 10-year follow-up (exclusion of CVD cases that occurred at baseline and during baseline and the 5-year follow-up).

All analyses were stratified by sex and conducted using the statistic software R (version 4.4.1, Vienna, Austria).

Results

Sample characteristics

Of the 15 010 individuals who participated at the GHS at baseline, 3753 were excluded because they were over 64 years old, 2121 participants were not employed, and 4999 had no information on workplace bullying because the COPOSOQ, which included the bullying questions, was administered to only about the half of the employed study population. The final study sample therefore comprised 4137 participants (who were included in at least one of the following analyses), of whom 3627 completed the single-item instrument and 4102 the five-item instrument.

The CVD sample for the single-item instrument comprised 3427 and the CVD sample for the five-item instrument 3875 participants (200 participants were subtracted from the 3627 participants who completed the single-item instrument and 227 participants from the 4102 participants who completed the five-item

instrument, respectively, as they had a CVD event at or before baseline). During the follow-up, of the CVD sample using the single-item instrument, 239 persons were censored due to moving (N=12), unknown reasons/lost contact (N=196), or death (N=31) and of the CVD sample using the five-item instrument, 264 participants were censored due to moving (N=11), unknown reasons/lost contact (N=217), and death (N=36).

For the workplace bullying trajectories analysis, we excluded participants who had experienced a CVD event between baseline and the 5-year follow-up (N=78) and participants with missing workplace bullying data at the 5-year follow-up (N=1008) from the CVD sample (N=3427), resulting in a final workplace bullying trajectories sample of 2341 participants. During the follow-up, 101 persons were censored for the following reasons: moving (N=1), no known reasons/lost contact (N=91), and death (N=9).

A comparison of the baseline characteristics between uncensored and censored cases, for both the single-item and five-item instrument analyses of the CVD samples, and for the workplace bullying trajectories sample, can be found in the Supplement (supplementary tables 1–3).

Of the 3627 participants who completed the single-item instrument at baseline, 1369 with prevalent hypertension were excluded, leaving 2258 eligible participants, of whom 516 did not attend the 10-year follow-up examination, leaving 1742 for the final hypertension analysis. Similarly, of the 4102 participants who completed the five-item instrument at baseline, 1558 with prevalent hypertension were excluded, leaving 2544 eligible participants, of whom 587 did not attend the 10-year follow-up examination, leaving 1957 for the final hypertension analysis.

Sample characteristics for the total population, men, and women are shown in table 1, and the study flow is illustrated in figure 2.

Association between workplace bullying and incident CVD

For the association between workplace bullying and CVD, the hazard ratio (HR) was 1.08 (95% CI 0.74–1.59) on the single-item instrument when adjusting for age, sex, and SES (Model 3), with similar patterns in men and women (table 2). On the five-item instrument, the HR in Model 3 in the total population was 1.28 (95% CI 0.95–1.72), with somewhat higher estimates in women (HR 1.51, 95% CI 0.89–2.57) than in men (HR 1.19, 95% CI 0.83–1.70). These results remained similar when adjusted for lifestyle factors (Model 4) and psychological factors (Model 5) (table 2).

Across the individual items of the five-item instrument, the CVD risk in the total population was increased, ranging from HR of 1.22–1.90 when adjusted for age, sex, and SES (Model 3) (supplementary table 4). For three items, the 95% confidence interval did not include unity: being ignored when addressing someone (HR 1.58, 95% CI 1.11–2.27), being blamed for others'

Table 1. Sample characteristics.

Variable	All (N=4137)		Men (N=2236)		Women (N=1901)	
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)
Age		48.3 (7.6)		48.5 (7.8)		48.1 (7.5)
Age groups						
35–44	1445 (35)		758 (34)		687 (36)	
45–54	1667 (40)		898 (40)		769 (41)	
55–64	1025 (25)		580 (26)		445 (23)	
Socioeconomic status (categories)						
Low	203 (5)		114 (5)		89 (5)	
Medium	2031 (49)		930 (42)		1101 (58)	
High	1899 (46)		1189 (53)		710 (37)	
Bullying						
Single-item instrument	554 (15)		288 (15)		266 (16)	
Five-item instrument – Composite	792 (19)		475 (21)		317 (17)	
Five-item instrument – Item 1 (Intentional interruption during oral contributions)	805 (20)		474 (21)		331 (18)	
Five-item instrument – Item 2 (Receiving no response when trying to speak to someone)	410 (10)		223 (10)		187 (10)	
Five-item instrument – Item 3 (Being blamed for others' mistakes or general operational problems)	689 (17)		449 (20)		240 (13)	
Five-item instrument – Item 4 (Removal of influential or working areas)	197 (5)		116 (5)		81 (4)	
Five-item instrument – Item 5 (Unpleasant sexual offers/sexual harassment)	23 (1)		8 (0)		15 (1)	
Cardiovascular disease						
Composite	230 (6)		150 (7)		80 (4)	
Acute myocardial infarct	46 (1)		38 (2)		8 (0)	
Coronary artery disease	74 (2)		63 (3)		11 (1)	
Sudden cardiac death	0 (0)		0 (0)		0 (0)	
Cerebral infarction/ischemic stroke	32 (1)		22 (1)		10 (1)	
Chronic heart failure	18 (1)		11 (1)		7 (0)	
Atrial fibrillation	49 (1)		35 (2)		14 (1)	
Peripheral artery disease	73 (2)		34 (2)		39 (2)	

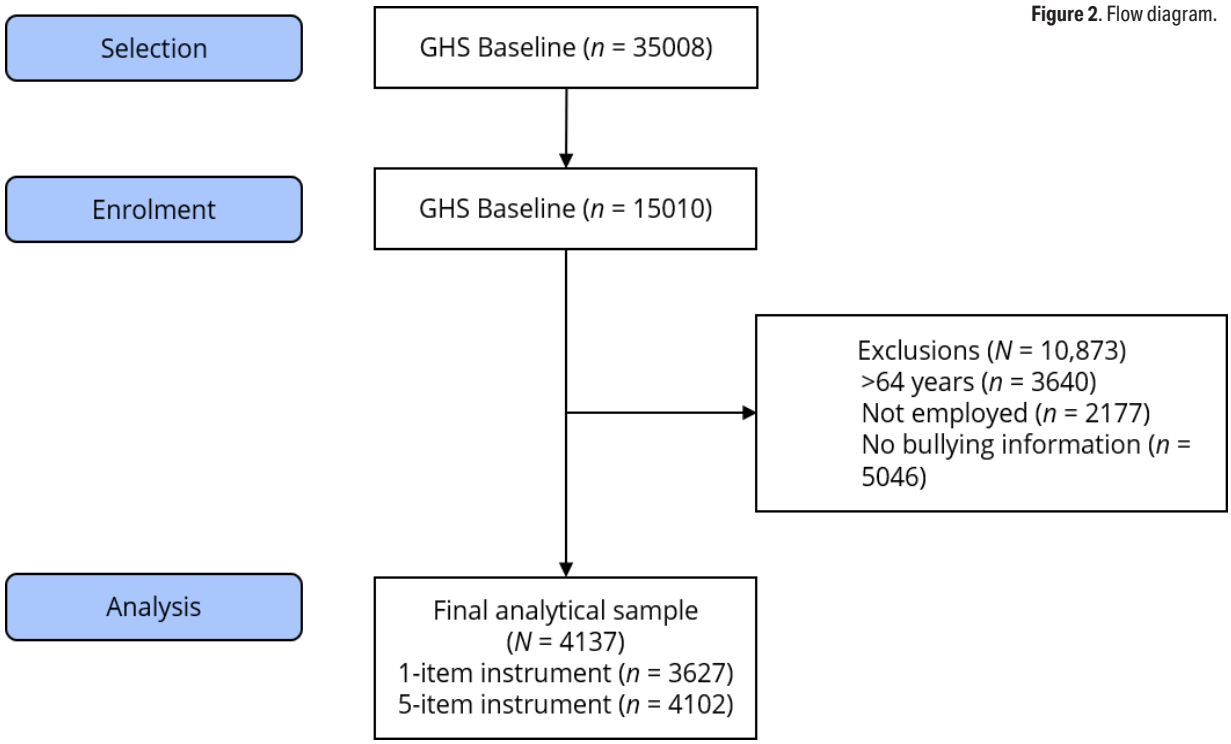


Figure 2. Flow diagram.

Table 2. Associations of workplace bullying at baseline with 10-year incidence of CVD. [CI=confidence interval; HR=hazard ratio; IR=incidence rate; IRR=IR ratio; N=number of participants; n=number of events; PY=person years; t_0 =Baseline]

Population	Bullying exposure t_0	N	n	Censored events	PY	IR (per 1000 PY)	Model 1 [a]		Model 2 [b]		Model 3 [c]		Model 4 [d]		Model 5 [e]	
							IRR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)
Single-item bullying instrument																
All	No	2906	169	2737	27 872	6.06		1		1		1		1		1
	Yes	521	32	489	4931	6.49	1.07 (0.73–1.56)	3427 (201)	1.15 (0.79–1.67)	3427 (201)	1.08 (0.74–1.59)	3425 (201)	1.09 (0.74–1.62)	3204 (189)	1.00 (0.67–1.48)	3408 (198)
Men	No	1512	112	1400	14 319	7.82		1		1		1		1		1
	Yes	271	22	249	2531	8.69	1.11 (0.70–1.76)	1783 (134)	1.20 (0.76–1.89)	1783 (134)	1.13 (0.71–1.79)	1781 (134)	1.15 (0.71–1.85)	1632 (122)	1.09 (0.68–1.76)	1776 (133)
Women	No	1394	57	1337	13 553	4.21		1		1		1		1		1
	Yes	250	10	240	2400	4.17	0.99 (0.51–1.94)	1644 (67)	1.05 (0.53–2.05)	1644 (67)	0.99 (0.51–1.95)	1644 (67)	0.98 (0.50–1.94)	1572 (67)	0.85 (0.42–1.71)	1632 (65)
Five-item bullying instrument																
All	No	3132	184	2948	30 033	6.13		1		1		1		1		1
	Yes	743	58	685	7024	8.26	1.35 (1.00–1.81)	3875 (242)	1.27 (0.95–1.71)	3875 (242)	1.28 (0.95–1.72)	3871 (241)	1.30 (0.95–1.76)	3609 (224)	1.23 (0.91–1.67)	3855 (237)
Men	No	1627	125	1502	15 413	8.11		1		1		1		1		1
	Yes	444	40	404	4153	9.63	1.19 (0.83–1.70)	2071 (165)	1.19 (0.83–1.70)	2071 (165)	1.19 (0.83–1.70)	2068 (164)	1.24 (0.85–1.80)	1890 (147)	1.16 (0.81–1.68)	2064 (163)
Women	No	1505	59	1446	14 620	4.04		1		1		1		1		1
	Yes	299	18	281	2871	6.27	1.55 (0.92–2.63)	1804 (77)	1.48 (0.88–2.51)	1804 (77)	1.51 (0.89–2.57)	1803 (77)	1.43 (0.85–2.44)	1719 (77)	1.43 (0.82–2.50)	1791 (74)

[a] Unadjusted.
[b] Adjusted for (sex), age.
[c] Adjusted for (sex), age, socioeconomic status.
[d] Adjusted for (sex), age, socioeconomic status, smoking status, alcohol consumption, waist-to-height ratio, physical activity.
[e] Adjusted for (sex), age, socioeconomic status, depression, Type D personality, anxiety disorder.

Table 3. Associations between workplace bullying trajectories and incident CVD. [CI=confidence interval; HR=hazard ratio; IR=incidence rate; IRR=IR ratio; N=number of participants; n=number of events; PY=person years]

Population	Bullying exposure t_0	N	n	Censored events	PY	IR (per 1000 PY)	Model 1 [a]		Model 2 [b]		Model 3 [c]		Model 4 [d]		Model 5 [e]	
							IRR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)
All	No	1800	46	1754	8780	5.24		1		1		1		1		1
	Cessation	221	0	221	1086	0	-*	/	-*	/	-*	/	-*	/	-*	/
	Onset	204	10	194	9802	10.20	1.95 (0.98–3.86)	2341 (63)	2.05 (1.03–4.07)	2341 (63)	1.96 (0.99–3.91)	2341 (63)	1.98 (0.96–4.09)	2181 (57)	1.81 (0.88–3.75)	2332 (62)
	Persistent	116	7	109	551	12.69	2.43 (1.10–5.37)	2341 (63)	2.63 (1.19–5.84)	2341 (63)	2.44 (1.09–5.44)	2341 (63)	2.41 (1.01–5.74)	2181 (57)	2.37 (1.02–5.47)	2332 (62)
Men	No	940	28	912	4565	6.13		1		1		1		1		1
	Cessation	114	0	114	558	0	-*	/	-*	/	-*	/	-*	/	-*	/
	Onset	110	7	103	522	13.41	2.18 (0.95–4.99)	1228 (40)	2.17 (0.95–4.97)	1228 (40)	2.07 (0.99–4.76)	1228 (40)	2.10 (0.85–5.19)	1118 (34)	1.95 (0.84–4.54)	1227 (40)
	Persistent	64	5	59	298	16.80	2.72 (1.05–7.06)	1228 (40)	2.90 (1.12–7.51)	1228 (40)	2.65 (1.01–6.96)	1228 (40)	2.67 (0.91–7.87)	1118 (34)	2.89 (1.07–7.84)	1227 (40)
Women	No	860	18	842	4215	4.27		1		1		1		1		1
	Cessation	107	0	107	528	0	-*	/	-*	/	-*	/	-*	/	-*	/
	Onset	94	3	91	458	6.54	1.54 (0.45–5.22)	1113 (23)	1.78 (0.52–6.06)	1113 (23)	1.71 (0.50–5.86)	1113 (23)	1.91 (0.56–6.58)	1063 (23)	1.21 (0.28–5.33)	1105 (22)
	Persistent	52	2	50	254	7.88	1.85 (0.43–7.98)	1113 (23)	2.08 (0.48–9.01)	1113 (23)	1.99 (0.46–8.62)	1113 (23)	2.24 (0.51–9.81)	1063 (23)	1.88 (0.41–8.67)	1105 (22)

[a] Unadjusted.
[b] Adjusted for (sex), age.
[c] Adjusted for (sex), age, socioeconomic status.
[d] Adjusted for (sex), age, socioeconomic status, smoking status, alcohol consumption, waist-to-height ratio, physical activity.
[e] Adjusted for (sex), age, socioeconomic status, depression, Type D personality, anxiety disorder.
* No cardiovascular events occurred in this exposure group; therefore, risk estimates could not be estimated.

Table 4. Associations between workplace bullying at baseline and 10-year incident hypertension. [CI=confidence interval; N=number of participants; n=number of events; RR=relative risk; t_0 =Baseline]

Population	Bullying exposure t_0	Model 1 [a]		Model 2 [b]		Model 3 [c]		Model 4 [d]		Model 5 [e]	
		RR (95 % CI)	N (n)	RR (95 % CI)	N (n)	RR (95 % CI)	N (n)	HR (95 % CI)	N (n)	HR (95 % CI)	N (n)
Single-item bullying instrument											
All	No		1		1		1		1		1
	Yes	1.08 (0.88–1.34)	1742 (476)	1.10 (0.89–1.35)	1742 (476)	1.04 (0.84–1.28)	1741 (476)	1.01 (0.83–1.24)	1621 (450)	1.05 (0.85–1.29)	1738 (476)
Men	No		1		1		1		1		1
	Yes	1.13 (0.88–1.47)	837 (269)	1.14 (0.88–1.48)	837 (269)	1.07 (0.83–1.39)	836 (269)	1.06 (0.83–1.36)	756 (248)	1.11 (0.85–1.44)	836 (269)
Women	No		1		1		1		1		1
	Yes	0.98 (0.69–1.40)	905 (207)	1.03 (0.72–1.47)	905 (207)	1.01 (0.71–1.44)	905 (207)	0.95 (0.67–1.34)	865 (202)	0.95 (0.67–1.35)	902 (207)
Five-item bullying instrument											
All	No		1		1		1		1		1
	Yes	0.99 (0.82–1.19)	1957 (540)	0.94 (0.78–1.14)	1957 (540)	0.94 (0.78–1.13)	1956 (540)	0.85 (0.70–1.02)	1820 (509)	0.94 (0.78–1.13)	1953 (540)
Men	No		1		1		1		1		1
	Yes	1.02 (0.82–1.27)	968 (318)	1.02 (0.82–1.27)	968 (318)	1.02 (0.82–1.26)	967 (318)	0.94 (0.75–1.17)	874 (293)	1.04 (0.83–1.29)	967 (318)
Women	No		1		1		1		1		1
	Yes	0.82 (0.58–1.17)	989 (222)	0.78 (0.55–1.11)	989 (222)	0.78 (0.55–1.11)	989 (222)	0.65 (0.46–0.95)	946 (216)	0.75 (0.53–1.06)	986 (222)

[a] Unadjusted.
[b] Adjusted for (sex), age.
[c] Adjusted for (sex), age, socioeconomic status
[d] Adjusted for (sex), age, socioeconomic status, smoking status, alcohol consumption, waist-to-height ratio, physical activity.
[e] Adjusted for (sex), age, socioeconomic status, depression, Type D personality, anxiety disorder.

mistakes or operational problems (HR 1.44, 95% CI 1.06–1.95), and having important working tasks withdrawn (HR 1.70, 95% CI 1.07–2.70).

Sensitivity analysis: Arterial ischemic CVD

When only examining incident arterial ischemic CVD, using the single-item instrument, HR were somewhat higher than for overall CVD (supplementary table 5): the HR for the total population was 1.36 (95% CI 0.86–2.15), for men 1.51 (95% CI 0.88–2.59), and for women 1.09 (95% CI 0.45–2.64). Using the five-item instrument, HR were similar to overall CVD (total population: HR 1.19, 95% CI 0.80–1.75; men: HR 1.09, 95% CI 0.69–1.72; women: HR 1.58, 95% CI 0.75–3.34).

CVD risk across workplace bullying trajectories

For onset bullying, the HR was 1.96 (95% CI 0.97–4.11) when adjusting for age, sex, and SES (Model 3) (table 3). The risk was even higher for persistent bullying at baseline and the 5-year follow-up at 2.44 (95% CI 1.09–5.44). No risk estimates could be calculated for bullying cessation as no CVD events occurred in this exposure group. The risk estimates were also similar when adjusting for lifestyle factors (Model 4) and psychological factors (Model 5).

Association between workplace bullying and hypertension

Overall, the analyses found no increased risk of incident hypertension associated with workplace bullying (table 4). For the total population, when adjusting for age, sex, and SES (Model 3), the risk was 1.04 (95% CI 0.84–1.28) when the single-item instrument was used, and 0.94 (95% CI 0.78–1.13) when the five-item instrument was used. No differences were shown between men and women. Adjusting for lifestyle factors (Model 4) and psychological factors (Model 5) showed similar risk estimates (table 4).

Considering the individual items of the five-item instrument, sexual harassment (item 5) was associated with a twofold increased risk of hypertension when adjusting for age, sex, and SES (Model 3) (total population: RR=2.04, 95% CI 1.13–3.65, men: RR=2.04, 95% CI 0.97–4.31, women: RR=2.02, 95% CI 0.87–4.72). The other four items showed no increased risk estimates (supplementary table 6).

Discussion

Principal findings

According to our findings, workplace bullying was not associated with the risk of 10-year CVD incidence when considered at baseline only. However, when considering workplace bullying trajectories, higher risk estimates were observed for those who reported onset bullying at the 5-year follow-up (HR 1.96, 95% CI 0.99–3.91) and when repeated experiences of workplace bullying were reported at baseline and after five years (HR 2.44, 95% CI 1.09–5.44). The stronger associations observed for onset and persistent workplace bullying, compared with the associations observed for workplace bullying measured only at baseline, may reflect differences in exposure timing and duration. Persistent workplace bullying may indicate sustained workplace bullying exposure, potentially increasing the risk for incident CVD.

However, the reason why onset workplace bullying showed higher CVD risk estimates than workplace bullying measured at baseline remains unclear. One possible explanation is that the observed associations may depend on the duration of follow-up. Shorter follow-up periods may capture more immediate cardiovascular consequences of workplace bullying, whereas associations may attenuate over longer periods if exposure does not persist. In our study, the elevated hazard ratio observed for onset workplace bullying may reflect the shorter interval between exposure assessment at the 5-year follow-up and outcome incidence between the 5- and the 10-year follow-up (ie, up to five years). Conversely, the longer follow-up period of ten years may help explain why workplace bullying assessed at baseline alone was not associated with the 10-year CVD incidence.

When restricting the outcome to arterial ischemic CVD, risk estimates were also not associated with workplace bullying measured as baseline. The results also showed no elevated risk estimates for incident hypertension associated with workplace bullying measured at baseline.

Comparison to other studies

Our findings showing increased risk estimates for CVD incidence at the 10-year follow-up associated with workplace bullying, at least when occurring repeatedly, point in the same direction as the results from previous observational studies. In our earlier analysis of the 5-year GHS follow-up data, we observed risk increases of 31% and 61% for the single-item and five-item instruments, respectively (21). Despite the similar risk estimates in the total population, sex-specific patterns differed between the 5-year and the present 10-year analyses

when using the five-item instrument. Whereas Romero Starke et al. reported a higher CVD risk estimate for men (HR 1.77, 95% CI 1.01–3.09), our current analysis showed a higher risk estimate for women (HR 1.51, 95% CI 0.89–2.57). No such differences were observed for the single-item instrument. These differences may partly reflect the longer follow-up and the corresponding additional cardiovascular events occurring between the 5-year and the 10-year follow-up. However, given the wide confidence intervals, these differences should be interpreted with caution.

The cohort study by Strømholm et al. (2015) with a one-year follow-up found an 80% increased risk of long-term sickness absence due to CVD (95 CI 0.93–3.48) among those exposed to workplace bullying and harassment, assessed jointly in a single question (22). In the multi-cohort study by Xu et al. (2019), the pooled HR for incident CVD associated with workplace bullying within the past twelve months was 1.59 (95% CI 1.28–1.98), pointing to a dose-response relationship; with the highest risk estimate being observed among those most frequently bullied (HR: 2.22, 95% CI 1.23–4.01) (23). Similarly, Kivimäki et al. (2003) reported 2.3-fold higher odds of CVD among bullied employees (20). Two additional studies examining conflict and violence at work (including a bullying item) found increased odds of 1.63 and 1.76, respectively (18, 19).

With regard to the potential influence of follow-up duration on the observed associations, the evidence from previous studies is mixed. Studies with relatively short follow-up periods (up to two years) generally reported increased risk estimates (18–20), although one study found no statistically significant association (22). This pattern may support the hypothesis that associations are more pronounced over shorter follow-up periods. However, the study by Xu et al. (23), with a mean follow-up duration comparable to that of our study (12.4 years), also reported a significantly increased risk of incident CVD, thus not supporting the assumption that a longer follow-up period might explain the lack of an association between baseline workplace bullying and 10-year CVD incidence in our study.

Only one other study to date examined the association between workplace bullying and incident hypertension, our previous cohort analysis based on the 5-year GHS follow-up, which, consistent with the present findings, reported no increased risk estimates (21). In contrast, a prospective U. S. cohort study with an eight-year follow-up investigating workplace discrimination, which is conceptually distinct from WPC, found an increased risk of incident hypertension (HR: 1.59, 95% CI 1.19–2.14) (35).

The mechanisms potentially linking workplace bullying to CVD remain unclear, and several pathways have been proposed (36). These include physiological processes such as the activation of stress axes, hemodynamic changes, proinflammatory states and accelerated plaque formation, as well as stress-induced changes in gene expression. Furthermore, the psychological consequences of workplace bullying, such as unhealthy behaviors (eg, smoking, lack of exercise, and alcohol consumption), sleep disorders and mental illness, may also increase cardiovascular risk.

Strengths and limitations

The main strength of this study is its prospective design, enabling temporal conclusions to be derived. Workplace bullying was assessed using two instruments with similar prevalences (15% and 19%), strengthening the robustness of the findings. The outcomes were measured objectively using hospital and physician records and death certificates. The study benefits from a large, population-based cohort. Sensitivity analyses were conducted for workplace bullying trajectories and arterial ischemic CVD, and analyses were stratified by sex.

Nevertheless, several limitations should be noted. The generalizability of the five-item instrument may be restricted, as it was originally developed for a predominantly male population, tending to reflect male-typed bullying experiences (eg, unfair blame) (37). In addition, it includes an item on sexual harassment, which does not adequately capture workplace bullying exposure, as shown in the examination of its psychometric properties in the GHS sample (29). The single-item instrument captures the same core behaviors described by Löbner et al. (3), but applies a different frequency operationalization, which may explain our higher prevalence of workplace bullying of 15% compared with their reported prevalence (7%). Consequently, some participants may have been classified as bullied under our broader definition who would not meet the stricter criteria, potentially affecting prevalence estimates and observed associations. In our main analysis, workplace bullying was measured only at baseline. Therefore, we were unable to account for potential changes of workplace bullying that may have influenced the observed associations, such as job or workplace changes, taking parental leave, or unemployment. Although we also examined workplace bullying trajectories, these assessments could not capture all changes in exposure status throughout the 10-year follow-up period.

The exclusion of participants with missing workplace bullying data at the 5-year follow-up in the workplace bullying trajectories analysis may have introduced selection bias if these participants differed systematically from those included in the analysis. In addition, comparisons of baseline characteristics between censored and uncensored participants showed different sex distributions, with a lower proportion of women among

censored participants across the analyses, also raising the possibility of selection bias.

Although we additionally adjusted for lifestyle and psychological factors, we cannot exclude residual confounding by unmeasured previous traumatic life experiences, bullying and sexual harassment outside the workplace, or personality characteristics, including neuroticism (8). Finally, as the GHS only included individuals aged 35 years and older, the impact of workplace bullying on younger employees could not be assessed, for whom CVD events would likely have been rare.

Implications for research and practice

As the foundations of mental and cardiovascular health are established in childhood and adolescence, behavioral interventions for affected individuals could help prevent negative outcomes in adulthood (36). Early identification and treatment of subclinical mental health conditions may reduce vulnerability to stressful workplace interactions and help interrupt the cycle of bullying and its behavioral and physiological consequences, making cardiovascular disease prevention a lifelong task.

At the workplace level, there is a strong need for action to prevent the health consequences of bullying (3). Preventive measures should be implemented at multiple levels and, in particular, consider organizational and managerial characteristics (3, 8). Specific workplace programmes for CVD prevention should recognize bullying as a potential risk factor and incorporate it into broader cardiovascular prevention strategies (36). Future observational and intervention studies are needed to evaluate the effectiveness of such programmes in real-world settings (36).

Concluding remarks

Our study found that individuals exposed to repeated workplace bullying at baseline and at 5-year follow-up were at an increased risk of incident cardiovascular disease. No increase in risk of cardiovascular disease was observed when workplace bullying was considered only once at baseline. Furthermore, we found no increased risk estimates for incident hypertension.

Given these findings and the consistency with previous observational studies, workplace bullying should be considered a potential psychosocial risk factor within comprehensive cardiovascular prevention efforts. Future research, including longitudinal and intervention studies, is needed to clarify causal pathways and evaluate the effectiveness of workplace-level prevention strategies.

Ethical approval

The study was approved by the local ethics committee and by the local and federal data safety commissioners (#837.020.07(5555)).

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Conflict of interest

None declared.

Data availability

The analysis presents clinical data of the Gutenberg Health Study (GHS), a large-scale population-based cohort with ongoing follow-up examinations. This project constitutes a major scientific effort with high methodological standards and detailed guidelines for analysis and publication to ensure scientific analyses of highest quality. Due to the Statutes and Rules of Procedure of the GHS, data are not made available for the scientific community outside the established and controlled workflows and algorithms. To meet the general idea of verification and reproducibility of scientific findings, we offer access to data at the local database in accordance with the ethics vote upon request at any time. The GHS steering committee convenes once a month and decides on access of internal and external researchers and use of the data and biomaterials based on a research proposal. Interested researchers can make their requests to the Principal Investigators of the Gutenberg Health Study (email: ghs@unimedizin-mainz.de). More information and contact details are available on: https://www.unimedizin-mainz.de/ghs/en/informationen-for-scientists/access-to-study-data-and-biomaterial.html.

Use of Artificial intelligence (AI) tools

ChatGPT and DeepL were used to improve the readability and English grammar.

References

1. Hong C, Liu Z, Gao L, Jin Y, Shi J, Liang R et al. Global trends and regional differences in the burden of anxiety disorders and major depressive disorder attributed to bullying victimization in 204 countries and territories, 1999-2019: an analysis of the Global Burden of Disease Study. Epidemiol Psychiatr Sci 2022 Nov;31:e85. https://doi.org/10.1017/S2045796022000683.

2. Fattori A, Neri L, Aguglia E, Bellomo A, Bisogno A, Camerino D et al. Estimating the Impact of Workplace Bullying: Humanistic and Economic Burden among Workers with Chronic Medical Conditions. BioMed Res Int 2015;2015:708908. https://doi.org/10.1155/2015/708908.

3. Löbner M, Welzel FD, Jung F, Pabst A, Buß A, Görres C, et al. Repräsentative Studie zum Thema Mobbing in der Arbeitswelt in der Bundesrepublik Deutschland [Workplace bullying among the working population in Germany – a representative study]. Bundesministerium für Arbeit und Soziales, Leipzig; 2025.

4. Colaprico C, Grima D, Shaholli D, Imperiale I, La Torre G. Workplace Bullying in Italy: A Systematic Review and Meta-Analysis. Med Lav 2023 Dec;114(6):e2023049. https://doi.org/10.23749/mdl.v114i6.14673.

5. Goh HS, Hosier S, Zhang H. Prevalence, Antecedents, and Consequences of Workplace Bullying among Nurses-A Summary of Reviews. Int J Environ Res Public Health 2022 Jul;19(14):8256. https://doi.org/10.3390/ijerph19148256.

6. Karatuna I, Jönsson S, Muhonen T. Workplace bullying in the nursing profession: A cross-cultural scoping review. Int J Nurs Stud 2020 Nov;111:103628. https://doi.org/10.1016/j.ijnurstu.2020.103628.

7. Camarda A, McAndrew NS, Wolf L, Bishop-Royse J. A Scoping Review of Workplace Bullying in Emergency and Intensive Care Settings. J Nurs Adm 2025 May;55(5):252–8. https://doi.org/10.1097/NNA.0000000000001572.

8. Feijó FR, Gräf DD, Pearce N, Fassa AG. Risk Factors for Workplace Bullying: A Systematic Review. Int J Environ Res Public Health 2019 May;16(11):1945. https://doi.org/10.3390/ijerph16111945.

9. Lever I, Dyball D, Greenberg N, Stevelink SA. Health consequences of bullying in the healthcare workplace: A systematic review. J Adv Nurs 2019 Dec;75(12):3195–209. https://doi.org/10.1111/jan.13986.

10. Theorell T, Hammarström A, Aronsson G, Träskman Bendz L, Grape T, Hogstedt C et al. A systematic review including meta-analysis of work environment and depressive symptoms. BMC Public Health 2015 Aug;15:738. https://doi.org/10.1186/s12889-015-1954-4.

11. Verkuil B, Atasayi S, Molendijk ML. Workplace Bullying and Mental Health: A Meta-Analysis on Cross-Sectional and Longitudinal Data. PLoS One 2015 Aug;10(8):e0135225. https://doi.org/10.1371/journal.pone.0135225.

12. Luo Z, Wang J, Zhou Y, Mao Q, Lang B, Xu S. Workplace bullying and suicidal ideation and behavior: a systematic review and meta-analysis. Public Health 2023 Sep;222:166–74. https://doi.org/10.1016/j.puhe.2023.07.007.

13. Holmgren R, Sørensen JK, Rugulies R, Xu T, Dalsager L, Madsen IE et al. Onset of exposure to workplace bullying and incident treatment with psychotropic medication - an emulated target trial with 25 309 Swedish and Danish employees. Epidemiol Psychiatr Sci 2026 Jan;35:e3. https://doi.org/10.1017/S2045796025100413.

14. Xu T, Magnusson Hanson LL, Clark AJ, Ersbøll AK, Westerlund H, Madsen IE et al. Onset of Workplace Bullying and Risk of Weight Gain: A Multicohort Longitudinal Study. Obesity (Silver Spring) 2020 Nov;28(11):2216–23. https://doi.org/10.1002/oby.22956.

15. Xu T, Magnusson Hanson LL, Lange T, Starkopf L, Westerlund H, Madsen IE et al. Workplace bullying and violence as risk factors for type 2 diabetes: a multicohort study and meta-analysis. Diabetologia 2018 Jan;61(1):75–83. https://doi.org/10.1007/s00125-017-4480-3.

16. Niedhammer I, Bertrais S, Witt K. Psychosocial work exposures and health outcomes: a meta-review of 72 literature reviews with meta-analysis. Scand J Work Environ Health 2021 Oct;47(7):489–508. https://doi.org/10.5271/sjweh.3968.

17. Sultan-Taïeb H, Villeneuve T, Chastang JF, Niedhammer I. Burden of cardiovascular diseases and depression attributable to psychosocial work exposures in 28 European countries. Eur J Public Health 2022 Aug;32(4):586–92. https://doi.org/10.1093/eurpub/ckac066.

18. Hu Z, Li J. Associations of Workplace Violence With Cardiovascular Disease Among United States Workers: Findings From a National Survey. J Prev Med Public Health 2023 Jul;56(4):368–76. https://doi.org/10.3961/jpmph.23.032.

19. Jacob L, Kostev K. Conflicts at work are associated with a higher risk of cardiovascular disease. Ger Med Sci 2017 Apr;15:Doc08. https://doi.org/10.3205/000249.

20. Kivimäki M, Virtanen M, Vartia M, Elovainio M, Vahtera J, Keltikangas-Järvinen L. Workplace bullying and the risk of cardiovascular disease and depression. Occup Environ Med 2003 Oct;60(10):779–83. https://doi.org/10.1136/oem.60.10.779.

21. Romero Starke K, Hegewald J, Schulz A, Garthus-Niegel S, Nübling M, Wild PS et al. Cardiovascular health outcomes of mobbing at work: results of the population-based, five-year follow-up of the Gutenberg health study. J Occup Med Toxicol 2020 Jun;15:15. https://doi.org/10.1186/s12995-020-00266-z.

22. Strømholm T, Pape K, Ose SO, Krokstad S, Bjørngaard JH. Psychosocial working conditions and sickness absence in a general population: a cohort study of 21,834 workers in Norway (The HUNT Study). J Occup Environ Med 2015 Apr;57(4):386–92. https://doi.org/10.1097/JOM.0000000000000362.

23. Xu T, Magnusson Hanson LL, Lange T, Starkopf L,

Westerlund H, Madsen IE et al. Workplace bullying and workplace violence as risk factors for cardiovascular disease: a multi-cohort study. Eur Heart J 2019 Apr;40(14):1124–34. https://doi.org/10.1093/eurheartj/ehy683.

24. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ 2007 Oct;335(7624):806–8. https://doi.org/10.1136/bmj.39335.541782.AD.

25. Wild PS, Zeller T, Beutel M, Blettner M, Dugi KA, Lackner KJ, et al. Die Gutenberg Gesundheitsstudie. [The Gutenberg Health Study]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. Jun 2012;55(6-7):824–9. https://doi.org/10.1007/s00103-012-1502-7

26. Hoffmann W, Latza U, Baumeister SE, Brünger M, Buttmann-Schweiger N, Hardt J et al. Guidelines and recommendations for ensuring Good Epidemiological Practice (GEP): a guideline developed by the German Society for Epidemiology. Eur J Epidemiol 2019 Mar;34(3):301–17. https://doi.org/10.1007/s10654-019-00500-x.

27. Daubenbüchel A. Analysis of characteristics, risk factors and mortality rate in dependence of response status at baseline in the Gutenberg Health Study. Master thesis. Johannes Gutenberg-Universität; 2014.

28. Nübling M, Stößel U, Hasselhorn HM, Michaelis M, Hofmann F. Measuring psychological stress and strain at work - Evaluation of the COPSOQ Questionnaire in Germany. Psychosoc Med 2006 Oct;3:Doc05..

29. Garthus-Niegel S, Nübling M, Letzel S, Hegewald J, Wagner M, Wild PS et al. Development of a mobbing short scale in the Gutenberg Health Study. Int Arch Occup Environ Health 2016 Jan;89(1):137–46. https://doi.org/10.1007/s00420-015-1058-6.

30. Leymann H. The content and development of mobbing at work. Eur J Work Org Psychol. 1996;5(2):165–84. https://doi.org/10.1080/13594329608414853

31. VanderWeele TJ. Principles of confounder selection. Eur J Epidemiol 2019 Mar;34(3):211–9. https://doi.org/10.1007/s10654-019-00494-6.

32. Hahad O, Gilan DA, Chalabi J, Al-Kindi S, Schuster AK, Wicke F et al. Cumulative social disadvantage and cardiovascular disease burden and mortality. Eur J Prev Cardiol 2024 Jan;31(1):40–8. https://doi.org/10.1093/eurjpc/zwad264.

33. Lampert T, Kroll L, Müters S, Stolzenberg H. Messung des sozioökonomischen Status in der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1). [Measurement of socioeconomic status in the German Health Interview and Examination Survey for Adults (DEGS1)]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. May 2013;56(5-6):631-6. https://doi.org/10.1007/s00103-012-1663-4.

34. Lampert T, Kroll LE, Müters S, Stolzenberg H. Messung des sozioökonomischen Status in der Studie „Gesundheit in Deutschland aktuell“ (GEDA). [Measurement of the socioeconomic status within the German Health Update 2009 (GEDA)]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. Jan 2013;56(1):131-43. https://doi.org/10.1007/s00103-012-1583-3.

35. Li J, Matthews TA, Clausen T, Rugulies R. Workplace Discrimination and Risk of Hypertension: Findings From a Prospective Cohort Study in the United States. J Am Heart Assoc 2023 May;12(9):e027374. https://doi.org/10.1161/JAHA.122.027374.

36. Herrmann-Lingen C. Victimization in the workplace: a new target for cardiovascular prevention? Eur Heart J 2019 Apr;40(14):1135–7. https://doi.org/10.1093/eurheartj/ehy728.

37. Eisermann J, de Costanzo E. Die Erfassung von Mobbing - Eine Konstruktvalidierung aktueller Datenerhebungsverfahren. [Assessing bullying – a construct validation of current data collection methods] Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA), Dortmund/Berlin/Dresden; 2011.

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