REVIEW ARTICLE

# Sleep, stress and recovery as determinants of cognitive performance and maintenance in working adults: an evidence-graded narrative review

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**ABSTRACT**

**Background:** Knowledge work depends on sustained attention, working memory and judgement, capacities that are sensitive to sleep, stress and recovery. Advice to working adults on these topics often moves faster than the evidence.

**Methods:** This evidence-graded narrative review drew on meta-analyses, randomised controlled trials, large cohorts and Mendelian randomisation studies on sleep and circadian habits, stress, mood, emotion regulation and recovery from work. Each component was graded on four levels (STRONG, MODERATE, LIMITED-EMERGING, NULL-CONTRADICTED) across three horizons: performance (hours to days), short-term maintenance (days to weeks) and long-term maintenance (years to decades).

**Results:** Cumulative sleep debt was the best-supported determinant of day-to-day performance (STRONG): 14 nights at 6 hours in bed impaired attention and working memory to the level of one night of total sleep deprivation, while felt sleepiness levelled off. Recovery from sleep debt was slower than its accumulation (MODERATE). Insomnia was associated with measurable cognitive deficits and lost work productivity (STRONG association), and digital cognitive behavioural therapy for insomnia improved work outcomes (MODERATE). Acute stress impaired working memory (g $-0.20$) and memory retrieval (g $-0.22$); clinical burnout carried deficits across cognitive domains (g $-0.36$ to $-0.53$); and psychological detachment from work was the strongest recovery correlate of lower fatigue, although no trial has shown that raising detachment causally improves fatigue or cognition. Over the long term, sleep regularity and objectively measured fragmentation were stronger signals than sleep duration, whereas sleep-stage percentages showed no association with dementia (NULL-CONTRADICTED). Most long-horizon findings were observational and partly explained by reverse causation, and founder-specific evidence was limited to small studies.

**Conclusions:** The largest levers are subtractive — protecting sleep, limiting acute stress and exhaustion, and enabling detachment — and their costs are under-felt. This favours objective, baseline-relative measurement over self-report. Trials in working-age professionals are needed.

## 1. Introduction

Knowledge work — including the work of founders, managers and other professionals — depends on a small set of cognitive capacities that fluctuate from day to day: sustained attention, working memory, flexible judgement and the ability to learn quickly. Sleep, stress and recovery are the most widely discussed influences on these capacities, and they are also the focus of a fast-growing market of wearables, apps and workplace programmes.

Popular advice in this area often moves faster than the evidence. Effects observed in laboratory samples of students are generalised to executives, long-term associations from older cohorts are presented as causal, and some widely shared claims have failed replication. Working adults and the people who build tools for them need to know which effects are large, which are reliable, and in whom they were measured.

This review grades the peer-reviewed evidence for sleep, stress and recovery as determinants of cognitive performance and its maintenance in working adults. It asks three questions: which components measurably change same-day and next-day performance; which sustain capacity across days and weeks; and which are associated with brain health over years and decades. For each component, it reports the size of the effect, the population studied, and whether the evidence supports association only or causation as well. It is one of three companion reviews; the others cover work habits, physical activity, learning strategies and generative AI, and popular cognitive-enhancement claims (companion reviews, in preparation).

## 2. Methods

### *2.1 Design*

This is an evidence-graded narrative review. It was not conducted as a systematic review, and no protocol was registered.

### *2.2 Scope*

The review was restricted to lifestyle and behavioural components: sleep and circadian habits, acute and chronic stress, mood and emotion regulation, and recovery from work. Environmental exposures, substances, supplements and medical risk factors were out of scope.

### *2.3 Search and selection*

Sources were identified through searches of PubMed/MEDLINE and of publisher and citation databases accessed through Digital Object Identifiers (DOIs), which also

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captured journals in occupational, organisational and management research that are not indexed in PubMed. Searches combined terms for each component listed in Section 2.2 with terms for cognitive outcomes (for example cognition, attention, working memory, memory, creativity, cognitive decline and dementia) and for study design (meta-analysis, systematic review, randomised controlled trial, cohort and Mendelian randomisation). Only English-language publications were included. The author selected and graded the evidence, with assistance from AI tools (Section 2.8). The final reference list comprises 181 sources published between 1988 and 2026, of which at least 165 are indexed in PubMed.

Priority was given to meta-analyses and umbrella reviews, randomised controlled trials (RCTs), large prospective cohorts and Mendelian randomisation (MR) studies. Working-age samples were preferred where they existed. This review is part of a programme of three companion reviews that drew on 17 topic-specific evidence summaries covering several hundred peer-reviewed sources.

### *2.4 Verification of figures*

Every quantitative figure was checked against the abstract or full text of its primary source. Figures that could not be verified against a primary source — for example, numbers reported only in press releases or effect sizes seen only in secondary summaries — were excluded.

### *2.5 Evidence grading*

Each component was graded on a four-level scale:

- **STRONG:** several consistent meta-analyses or RCTs.
- **MODERATE:** one good meta-analysis, or consistent large cohorts or trials.
- **LIMITED-EMERGING:** single or small studies, or indirect or conflicting evidence.
- **NULL-CONTRADICTED:** well-powered tests or replications failed.

Where the evidence fitted none of these levels, a plain descriptor is used ("unsupported", "untested", "conflicting" or "no direct evidence"). Where association and causation diverge, both grades are given. Where independent grading of the same evidence differed, the range is reported.

### *2.6 Time horizons*

Each component was assigned to one or more horizons: PERFORMANCE (hours to days, including learning and memory consolidation), M-SHORT (sustaining capacity over days to weeks) and M-LONG (protecting the brain over years to decades).

### *2.7 Effect sizes*

Effect sizes are reported as standardised differences (SMD, $d$ or $g$), where about 0.2 is small and about 0.5 is medium, or as hazard ratios (HR), risk ratios (RR) and odds ratios (OR) as reported by the source studies.

### *2.8 Use of AI tools*

Generative AI tools, including Claude (Anthropic), were used in part to assist with identifying and summarising literature, structuring the manuscript, preparing figures and editing language. The author reviewed all AI-assisted content, checked every claim, figure and reference against the primary sources, and takes full responsibility for the content of this article. AI tools are not listed as authors.

## 3. Results

### *3.1 Most evidence comes from students and adults over 50, not working-age professionals*

The population constraint shapes every conclusion of this review. Most experimental performance evidence comes from undergraduates doing laboratory tasks, and most dementia and decline evidence comes from cohorts recruited after age 50. Working-age evidence exists in pockets: the Whitehall II (London civil servants recruited at 35–55), CARDIA (recruited at 18–30) and VISAT (French workers aged 32–62) cohorts, the IPD-Work consortium (mean age 45.5), physician and resident trials, a handful of workplace RCTs, generative-AI field experiments, and — for founders specifically — a few diary studies of 55–121 founders, one randomised sleep-deprivation experiment of uncertain sample (Gish 2019), one study of 377 small-business owners (Fernet 2016), one of 203 entrepreneurs (Drnovšek 2025) and one field experiment in Kenyan entrepreneurs (Otis 2026). Reverse causation runs through the long-horizon evidence: in 19 cohorts with a mean baseline age of 45.5, physical inactivity predicted dementia (HR 1.40) only when measured less than 10 years before diagnosis, and not when measured 10 or more years before (HR 1.01) [1]; the same pattern appears for social and cognitive activities [2] and body weight [3]. The report therefore uses "associated with" language for M-LONG claims unless trials or Mendelian randomisation say more.

### *3.2 Short nights build a debt that people stop feeling*

One night without sleep (24–48 hours awake) degrades exactly the abilities knowledge work depends on, and does so unevenly. Pooling 70 studies, attention lapses worsened by g $-0.76$, working-memory accuracy by $-0.55$ and complex-attention accuracy by $-0.48$, while processing-speed accuracy ($-0.25$) and logical reasoning ($-0.125$) did not change significantly [4]. The profile may explain a common experience among founders and other professionals: people feel able to "think" because reasoning is spared while lapses and working-memory errors multiply. Wakefulness has been equated with alcohol: 17–19 hours awake matched a 0.05% blood alcohol concentration on some tests in 39 transport and army workers, and longer wakefulness reached the 0.1% level [5]; an earlier one-page *Nature* letter reported a similar pattern on a psychomotor tracking task [6] — a MODERATE grade that applies to psychomotor tasks, not all cognition. In physicians, under 30 hours of sleep loss cut overall performance by nearly 1 SD and clinical performance by more than 1.5 SD [7].

Chronic restriction is the more realistic founder exposure, and its cost accumulates. In a randomised laboratory study of adults aged 21–38, 14 nights at 6 hours in bed drove attention lapses and working-memory deficits to the level seen after one full night without sleep, and 14 nights at 4 hours to the level of two, while subjective sleepiness rose and then flattened and did not distinguish 6 from 4 hours — participants were "largely unaware" of their growing deficits [8]. A meta-analysis of 61 restriction studies gives an overall effect of g $-0.38$, with executive function $-0.32$, sustained attention $-0.41$ and long-term memory $-0.19$ [9], and even 7 hours in

bed slowed responses relative to 9 hours in a 66-person dose-response study [10]. A single short night of 2–6 hours is narrower: it reliably impairs sustained attention (reaction time SMD 0.51; lapses 0.49) but has no significant effect on working memory, inhibitory control or throughput in a 44-study meta-analysis [11]. Vulnerability to sleep loss is a stable, trait-like individual difference, larger than the effect of sleep history [12], which argues for comparing each person with their own baseline. Grade: STRONG for cumulative debt (PERFORMANCE, M-SHORT); MODERATE for the gap between felt and measured impairment — so an objective performance probe or a running sleep-debt estimate is more informative than asking people how they feel.

Recovery takes longer than a weekend. After five nights at 4 hours, one recovery night of 10 hours in bed (about 9 hours asleep) left vigilance, sleepiness and fatigue incompletely restored in 159 adults aged 22–45 [13]; after a working-week pattern of six nights at 6 hours, two 10-hour nights normalised sleepiness and the inflammatory marker IL-6 but vigilance "did not improve after recovery" [14]; and lapses had not fully recovered even after four 12-hour recovery nights [15]. An older study found two full nights sufficient [16], so the exact repayment rate is unsettled; grade MODERATE (M-SHORT). In 15 young men, one hour of "potential sleep debt" took about four days to recover [17] (LIMITED-EMERGING). Banking extra sleep before a known crunch protected vigilance during later restriction in 24 adults [18] (LIMITED-EMERGING). Behavioural sleep-extension programmes lengthen sleep (SMD 0.80), with fixed bed and wake times outperforming education [19], but the cognitive pay-off is mixed: ROTC cadets gained vigilance and Trail-Making speed after about 1.4 extra hours [20], while two small randomised crossover trials found no cognitive benefit [21,22] — consistent with extension helping mainly people below their own need (LIMITED-EMERGING). In UK Biobank adults over 50, moderate weekend catch-up sleep (1–1.5 hours) was associated with lower dementia risk (HR 0.64), but non-linearly and in a single cohort [23] (LIMITED-EMERGING, M-LONG).

### *3.3 Sleep shapes learning, mood and judgement*

The night *before* learning matters more than the night after. Total sleep deprivation before learning impaired later memory by g 0.62 (0.46 after trim-and-fill bias adjustment), versus g 0.28 (0.17 adjusted) for deprivation after learning [24]; across 271 samples, sleep beat equivalent wake time for retaining episodic memories by g 0.44, or 0.28 after correcting for selective reporting [25]. A review of replication failures concludes the benefits are smaller and more task-dependent than once assumed [26], so the grade is STRONG for existence and MODERATE for size (PERFORMANCE). One *Nature* experiment found sleep more than doubled the share of people who discovered a hidden rule [27] (LIMITED-EMERGING for insight).

Mood is the most consistent "soft" casualty. Across 154 experiments (5,717 participants), sleep loss lowered positive affect (SMD $-0.27$ to $-1.14$) and raised anxiety (SMD 0.57–0.63) [28], with positive mood down by g $-0.94$ in a second meta-analysis [29] — STRONG for positive affect and anxiety. Effects on negative mood are mixed and were weaker in adults aged 60–72 than in 18–30-year-olds [30], and whether sleep loss impairs adult emotion *regulation* is untested (the significant estimate comes from youth samples).

For judgement, a review framed around managers found rule-based, convergent reasoning largely spared by short-term sleep loss, while decisions involving "the unexpected, innovation, revising plans" and communication were impaired [31]; divergent thinking also suffered in small 1988–1992 experiments [32,33]. That is precisely the founder's decision profile. Founder-specific evidence points the same way but is thin. Three studies including a randomised sleep-deprivation experiment found that a good night's sleep improved entrepreneurs' ability to imagine promising venture ideas and form accurate beliefs about their attractiveness, though the experimental sample and effect sizes are not reported in the abstract [34]. In 121 entrepreneurs tracked for 10 days, better nightly sleep quality predicted more innovative behaviour the next day through high-activation positive mood [35]; daily recovery predicted daily idea generation in 62 entrepreneurs [36]; and in 77 entrepreneurs, being undermined by work partners disrupted that night's sleep and lowered next-day engagement [37]. In leaders, nightly sleep *quality* (not quantity) predicted next-day abusive supervision and lower team engagement [38]; sleep-deprived leaders were rated less charismatic [39]; and lost sleep after the daylight-saving shift was followed by more cyberloafing [40]. But an actigraphy study of 178 leaders found no main effect of leader sleep *quantity* on supportive behaviour, with interactions involving insomnia symptoms and night-time waking inconsistent in direction [41], and the "self-control depletion" mechanism these studies invoke failed large preregistered replications [42,43] — so the grade is LIMITED-EMERGING (PERFORMANCE). Across 152 studies of workers, sleep quality and quantity both correlate with workload, health, attitudes and affect [44] (MODERATE association).

Physician schedule trials show both the cost of long wakefulness and the limits of simply capping hours. Eliminating interns' extended shifts added 5.8 hours of sleep a week and more than halved attentional failures [45] and reduced serious medical errors by about 26% (136.0 vs 100.1 per 1,000 patient-days), with 5.6-fold more diagnostic errors on the traditional schedule [46]; interns working five or more extended shifts a month had 7.5-fold odds of a fatigue-related significant error [47]. Yet a multicentre trial found *more* errors (RR 1.53) when 24-hour shifts were removed while workload per resident rose (8.8 vs 6.7 patients) — an excess that disappeared after adjusting for workload [48] — and next-day surgical outcomes were no worse after attending surgeons had worked overnight (aOR 0.99) [49]. Grades: STRONG that extended wakefulness impairs professionals; MODERATE that cutting extended shifts improves sleep and attention, with conflicting replication for patient-safety outcomes (on a stricter reading, the claim that hours rules alone reduce errors is NULL-CONTRADICTED) — total load, not hours alone, matters.

### *3.4 Regularity and fragmentation carry the long-term signal; sleep-stage percentages do not*

For long-term outcomes, habitual duration shows an inverted-U association with cognition and dementia, with the lowest risk around 7 hours (6.4–7.8 hours across organ "ageing clocks" [50]); $\leq$4 hours and $\geq$10 hours both went with faster decline in 20,065 adults mostly over 50 [51]. In Whitehall

II civil servants, sleeping ≤6 hours at age 50 (HR 1.22) and 60 (HR 1.37) was associated with higher dementia risk over 25 years, though persistent short sleep across 50–70 gave a borderline HR of 1.30 (p = 0.048) that was not robust in sensitivity analyses [52]; in the same cohort aged 45–69, adverse changes in sleep duration were associated with cognitive scores equivalent to 4–7 years of ageing [53]. Causation is doubtful. A meta-analysis that split studies by follow-up length found short sleep predicted dementia only within 10 years (RR 1.46) and not beyond (RR 1.12, 0.95–1.29), whereas long sleep (≥9 hours) stayed associated (RR 1.74) [54]; Mendelian randomisation finds little causal effect of sleep traits on Alzheimer's disease or dementia [55,56]; 3,893 adults with repeated MRI showed no link between sleep duration and atrophy, with a cross-sectional brain-volume optimum of 6.5 hours [57]; and the 2024 Lancet Commission did not list sleep among its 14 modifiable dementia risk factors [58]. One single-author Mendelian randomisation study did link genetically predicted short sleep to lower cognitive-test scores [59] (LIMITED-EMERGING). Grades: MODERATE association for ~7 hours (M-LONG); LIMITED-EMERGING to NULL-CONTRADICTED for "short sleep causes dementia". Sleep drifting *longer* deserves attention — a transition from short to long sleep carried RR 1.94 [60] — but whether long sleep is a marker or a cause is conflicting.

Regularity is the stronger trackable signal. Among 88,094 UK Biobank adults (mean age 62) with accelerometers, the least regular 5% of sleepers had a 53% higher dementia hazard than median sleepers (HR 1.53), with a U-shaped curve, no further gain at the most regular end, and the lowest grey-matter and hippocampal volumes at the extremes [61]. Regularity predicted mortality better than duration [62], and a National Sleep Foundation consensus states that consistent sleep and wake timing matters for health, safety and performance [63] — MODERATE (M-LONG). Performance evidence is LIMITED-EMERGING: regularity correlated with grades (r = 0.37) in 61 undergraduates [64], and a randomised trial that shifted "night owls" about two hours earlier improved morning reaction time and reduced depression and stress [65]. Because regularity-index cut-offs depend on the processing algorithm, each person is best compared with their own baseline.

Objectively measured fragmentation is the best-supported quality metric. In CARDIA, 526 adults whose wrist actigraphy (about six nights) placed them in the most fragmented third at mean age 40 had 2.97-fold odds of a poor processing-speed (Digit Symbol) score 11 years later, and higher odds of poor fluency (OR 2.42) and MoCA (OR 2.29) scores, with no significant association reported for the Stroop executive test, whereas questionnaire-rated sleep quality (PSQI) and duration were *not* associated after full adjustment; baseline cognition was not controlled, and only the top third (fragmentation >20.6%) differed [66]. In older adults, each SD of fragmentation raised Alzheimer's risk by 22% [67], and weak 24-hour rest-activity rhythms were associated with incident dementia or mild cognitive impairment (a combined endpoint, 555 cases) in 91,517 adults aged 43–79 (HR 1.23 per SD lower relative amplitude; HR 1.32 per SD lower cosinor amplitude), though day-to-day stability (interdaily stability) was null [68] — MODERATE association (M-LONG). By contrast, single-night REM% and slow-wave % had *no* association with dementia in a pooled analysis of five cohorts (4,657 adults) [69] (NULL-CONTRADICTED), so wearable sleep-stage percentages should not be shown as brain-health readouts; a decline in slow-wave sleep over time predicted dementia in one cohort [70] (LIMITED-EMERGING). Self-rated sleep quality largely failed to predict objective cognition in 235 students, with Bayes factors favouring no association [71] (LIMITED-EMERGING, largely null). Mechanistically, one night of deprivation raised hippocampal $\beta$-amyloid in 20 adults [72] and CSF tau by more than 50% [73], but the "glymphatic brain-washing" model is contested in animal work [74] — LIMITED-EMERGING; "sleep flushes toxins" should not be marketed as settled.

### *3.5 Insomnia is common, costly at work and treatable*

Insomnia carries measurable cognitive deficits: overall g −0.24 across 48 studies (n = 4,539), largest for working-memory manipulation (−0.52), problem solving (−0.39) and complex attention (−0.36), and smallest, though still significant, for alertness (−0.14) [75], and episodic memory −0.51 in an earlier meta-analysis [76] — STRONG association (PERFORMANCE, M-SHORT). Because simple alertness is the least affected domain, a reaction-time test alone will understate insomnia-related impairment. The workplace cost is large: among 7,428 employed adults, 23.2% had insomnia, which was associated with presenteeism worth 7.8 lost workdays a year after controlling for 26 comorbidities (about $2,280 per worker) but not with absenteeism [77] (one affiliation listed Sanofi-Aventis and two errata were not checked), and worsening subclinical sleep problems predicted lower performance ratings in state employees [78].

Digital cognitive behavioural therapy for insomnia (dCBT-I) is the one sleep intervention with randomised evidence for work outcomes. In a Fortune 500 company, 270 poor sleepers aged 23–56 improved their sleep by d 1.10 (vs 0.34 on the wait-list) and presenteeism by d 0.64 (vs 0.09), with no significant change in absenteeism [79]; in 1,711 adults, dCBT-I improved fatigue (d ≈ 0.7), presenteeism (d ≈ 0.4) and self-reported cognitive failures (d ≈ 0.2) [80]. Both trials involved authors affiliated with Big Health, the developer of the programme tested. A pooled analysis of 11 RCTs found presenteeism SMD −1.05 at low-to-very-low certainty [81], and seven RCTs gave moderate-quality evidence that full CBT-I improves both absenteeism and presenteeism [82]. Objective cognitive gains are not established — only 4 of 18 studies measured them [83]. Grades: MODERATE for daytime function and work outcomes; LIMITED-EMERGING for objective cognition. For dementia, insomnia-specific meta-analyses give modest risks (RR 1.13–1.43), but every insomnia subtype was null and estimates were inflated at short follow-up [84], and Mendelian randomisation is mostly null and suggests Alzheimer's disease alters sleep rather than the reverse [85] — LIMITED-EMERGING to MODERATE association, contested. The case for treating insomnia in working adults rests on next-day function, not dementia prevention.

### *3.6 Naps, timing, light and pre-sleep habits are second-order levers*

Planned afternoon naps give a reliable small boost: d 0.38 overall across 54 studies (vigilance 0.61, procedural memory 0.49, declarative memory 0.38), with no moderation by nap length [86], and ES 0.18 for cognition and 0.29 for alert-

ness, lasting about two hours, in 11 mostly laboratory studies of working-age adults whose naps averaged about 55 minutes [87] — STRONG for planned naps in general (PERFORMANCE). Neither meta-analysis tests short naps specifically, so the advice to keep naps under about 30 minutes rests on the single-study and sleep-inertia evidence below. After a 5-hour night a 10-minute nap helped immediately and for 155 minutes, while a 30-minute nap first produced grogginess [88] (LIMITED-EMERGING). Sleep inertia typically clears within 15–30 minutes but full recovery takes at least an hour, and it is worse after sleep loss and after naps over about 30 minutes [89] (MODERATE) — so big decisions should not come straight off a nap. Habitual napping and long-term cognition are conflicting: one cohort meta-analysis associated napping with lower risk [90], another found higher risk with daily naps over 30 minutes (OR 1.35) [91], and a third found no longitudinal association [92] — LIMITED-EMERGING; napping should not be presented as brain-protective.

Matching demanding work to one's chronotype peak (the "synchrony effect") is weak in working-age adults: a systematic review found synchrony in only 29 of 64 studies (45%) of 18–45-year-olds versus 83% in older adults, with no main effect of chronotype in over 80% of studies [93]; 48,881 internet users showed no synchrony advantage, but inhibitory control declined steadily into the night until 01:00–02:00 [94]; and Mendelian randomisation finds chronotype has no causal effect on cognitive ability [95]. Grades: synchrony scheduling LIMITED-EMERGING; "avoid inhibition-heavy, high-stakes work late at night" LIMITED-EMERGING; "evening types are cognitively inferior" NULL-CONTRADICTED. The mid-afternoon dip occurs even without lunch [96] (LIMITED-EMERGING to MODERATE). Chronic circadian misalignment is a long-horizon exposure: in the VISAT cohort of 3,232 French workers, more than 10 years of shift work was associated with cognitive loss equivalent to 6.5 years of ageing, with recovery taking at least five years after leaving [97]; a meta-analysis gives a modest dementia risk (RR 1.15), with stronger signals for persistent night work and *reduced* risk in continuous-evening-shift subgroups [98]; and in nurses, night shifts degraded performance (g 0.39) only modestly more than day shifts (g 0.24) [99] — MODERATE (M-LONG). Jet lag in business travellers is LIMITED-EMERGING: airline cabin crew with repeated jet lag showed cognitive deficits after several years [100], and corporate-wellness clients travelling 21 or more nights a month reported more trouble sleeping (PR 1.37), anxiety (1.69) and depressive symptoms (2.27) than those away 1–6 nights [101].

Light timing is a circadian rather than a direct cognitive tool. An expert consensus sets indoor targets of at least 250 lux melanopic equivalent daylight illuminance at the eye during the day, no more than 10 lux from three hours before bed and no more than 1 lux during sleep — targets based on circadian physiology, not cognitive outcomes [102]. In more than 400,000 UK Biobank adults, each extra hour outdoors was associated with easier waking (OR 1.46–1.49), less tiredness (OR 0.80–0.82) and fewer insomnia symptoms [103]. Four hours a night of a light-emitting e-reader suppressed melatonin by 55%, delayed the clock 1.5 hours and lengthened sleep onset by about 10 minutes in 12 people, but no cognitive test was given [104]; a National Sleep Foundation panel reached consensus on screen harm only for children and adolescents [105]; iPhone Night Shift made no difference to sleep in an RCT [106]; and blue-light glasses have very-low-certainty evidence [107]. Grades: daylight and dark nights MODERATE for circadian, sleep and mood outcomes (M-SHORT) but LIMITED-EMERGING for cognition; typical adult evening screen use LIMITED-EMERGING and contested; spectral filters NULL-CONTRADICTED. Pre-sleep habits matter modestly: bedtime procrastination correlates with shorter (z −0.31) and poorer (z −0.35) sleep and daytime fatigue (z 0.32) [108] (GRADE low); writing a specific to-do list for five minutes at bedtime shortened polysomnography-measured sleep onset in 57 adults aged 18–30 [109] (LIMITED-EMERGING); and multicomponent sleep-health programmes improved sleep quality in non-clinical adults aged 18–64 (g −0.54) [110] (MODERATE, M-SHORT). Evening exercise does not harm sleep overall [111,112]; the warning against vigorous sessions ending within an hour of bed rests on fragile moderator effects and a low-certainty signal of more night-time waking at higher intensities [113] (LIMITED-EMERGING).

### *3.7 Acute stress taxes working memory and risky decisions*

Acute stress reliably but modestly impairs the executive core of knowledge work. Pooling laboratory studies of mostly 18–29-year-olds, stress lowered working memory by g −0.20 (34 studies) and memory retrieval by g −0.22 (31 studies) [114,115]; cognitive flexibility fell by g −0.30 but in only six studies (LIMITED-EMERGING), overall inhibition was unaffected (cognitive inhibition worse, response inhibition better), and stress *after* learning actually enhanced memory (g +0.21). Stress shifted decisions under uncertainty toward reward-seeking risk (d 0.17; 0.26 where risk was disadvantageous) [116] but did not alter smaller-sooner versus larger-later choices [117]. A systematic review hypothesises that noradrenaline-driven impairment appears within about 10 minutes and cortisol-driven impairment from about 25 minutes [118] — a scheduling heuristic, not a tested rule. Grades: MODERATE–STRONG for working memory and retrieval, MODERATE for risky decisions (PERFORMANCE). In daily life, stress *anticipated on waking* predicted poorer working memory later that day in 240 community adults aged 25–65 [119] (LIMITED-EMERGING), and over 100 days working memory was lower on high-negative-affect days [120]. The popular claim that moderate stress optimises work performance (Yerkes-Dodson) has no direct empirical support: the original 1908 law concerned habit formation in mice and was later recast without evidence [121,122]; induced stress lowered creativity overall (d −0.20), with time pressure most harmful to adults and the gain from mild evaluative threat not significant [123]. Grade: unsupported — no well-powered test exists, so it is not formally NULL, but it should not be promoted. Reframing arousal as functional ("stress reappraisal") produced a small performance gain across 35 RCTs (d 0.23, shrinking to d 0.14 after correction for publication bias; mean age 22.6, mostly exams and speeches) [124] and reduced subjective but not physiological stress [125] — LIMITED-EMERGING to MODERATE.

### *3.8 Depression, anxiety and burnout carry measurable cognitive deficits*

Clinical depression carries moderate deficits in executive function, memory and attention (d −0.34 to −0.65), and executive and attention deficits persist after remission (d −0.52 to −0.61) [126,127] — STRONG in clinical major depression, not established at subclinical symptom levels. Self-reported anxiety is associated with lower working-memory capacity (g −0.33; 177 samples, N = 22,061) [128] — MODERATE–STRONG (correlational). Over the long term, the Lancet Commission classes midlife depression as a modifiable dementia risk factor (RR 2.25 at 10–14-year follow-up) [58], and in 354,313 UK Biobank adults aged 50–70, treated depression carried lower dementia risk than untreated (HR 0.70) [129]. But in Whitehall II civil servants, midlife depressive symptoms did not raise dementia risk (HR 1.21, n.s.), and symptom trajectories diverged only about 11 years before diagnosis [130]; Mendelian randomisation is mixed — null for Alzheimer's disease in four studies, positive in one [131], positive for vascular dementia in another [132]. Grade: MODERATE association, causality contested (M-LONG); anxiety → dementia LIMITED-EMERGING (RR 1.24–1.29 [133]). For non-clinical tools, symptom screening with referral is the evidence-aligned role; treatment itself is clinical.

Clinical burnout is the work state with documented objective deficits. Across 17 studies, 730 patients with clinical burnout (exhaustion disorder) performed worse than 649 controls on episodic memory (g −0.36), working memory (−0.36), executive function (−0.39), attention and processing speed (−0.43) and fluency (−0.53), with crystallised ability spared [134] — MODERATE (PERFORMANCE, M-SHORT); evidence in non-clinical burned-out workers is LIMITED-EMERGING [135], and an EEG study suggests burned-out workers compensate so output looks normal while efficiency drops [136]. Chronic or perceived stress is associated with later impairment: higher perceived stress HR 1.44 for dementia and 1.19 for mild cognitive impairment across prospective studies [137]; in women aged 38–60 followed 35 years, dementia risk rose with the number of examinations reporting stress (HR 1.10, 1.73 and 2.51 for one, two and three) [138]; midlife work stress predicted dementia (OR 1.53) in the Finnish CAIDE cohort at mean age 71 but not at mean age 78 [139]; each additional symptom of vital exhaustion raised dementia incidence by about 2% [140]; and job design matters more than demands — passive jobs (RR 1.15) and high-strain jobs (RR 1.21) were associated with decline [141], low job control with dementia (OR 1.17) [142], and passive versus active jobs with HR 1.58 in a 19-year Swedish cohort [143]. A review rated the overall quality "low" [144], and stress is not a Lancet risk factor. Grade: MODERATE association, LIMITED causal (M-LONG) — persistence over months, not daily spikes, is the signal to track. For founders, who usually have high control, the employee-derived "high demands = harm" model fits poorly: a meta-analysis found that *challenge* stressors raised entrepreneurs' performance without harming well-being, while *hindrance* stressors harmed well-being without improving performance [145] (MODERATE), and whether entrepreneurs fare better than employees is only "partly positive", depending on the well-being component and institutional context [146]; a review of 144 studies of entrepreneurs' mental health found no study measuring objective cognitive performance [147].

### *3.9 Rumination, positive mood and emotion-regulation tools*

Repetitive negative thinking has a specific, modest working-memory cost — difficulty discarding no-longer-relevant information (r −0.20 across 94 studies) — with no consistent link to other control functions [148], although an earlier meta-analysis linked rumination to poorer inhibition (r −0.23) and shifting (−0.19) [149] and a 2025 analysis of 223 studies suggests self-control deficits precede symptoms, which precede rumination [150]. Its better-replicated cost runs through physiology and sleep: perseverative cognition raises cortisol (g 0.36) and heart rate and lowers heart-rate variability [151], and it mediates the link from perceived stress to poor sleep (indirect $\beta$ 0.09 [152]) — MODERATE (PERFORMANCE via working memory; M-SHORT via sleep), causal direction uncertain. Expressive writing reduces distress only slightly (g −0.12, better with sessions 1–3 days apart [153]); its claimed working-memory benefit rests on small student studies [154] (LIMITED-EMERGING), and the pre-exam "write about your worries" effect failed a high-powered preregistered replication (d 0.06 versus an original 2.48 [155]) and a 21-study meta-analysis [156] — NULL-CONTRADICTED. Positive mood modestly enhances creativity versus neutral mood (r 0.15), especially activating moods such as happiness, while fear and anxiety reduce cognitive flexibility [157] (MODERATE) — a reason to schedule brainstorming when energised, not merely calm.

Mindfulness programmes produce small cognitive gains that shrink against active controls: g 0.15 overall and 0.23 for working memory across 56 RCTs, beating inactive but not active comparators [158], and g 0.19–0.39 versus active controls across 111 RCTs, with larger effects for face-to-face than self-guided delivery — a caution for self-guided digital delivery [159] — LIMITED-EMERGING to MODERATE (PERFORMANCE). In workplace RCTs mindfulness reduced stress (g 0.56), anxiety (0.62) and distress (0.69) versus mostly inactive controls [160], but in non-clinical adults it showed no superiority over specific active alternatives and GRADE certainty was moderate to very low [161] — MODERATE for stress versus doing nothing (M-SHORT). Effects on work task performance were small (g 0.25 versus passive controls), null versus active controls and very-low certainty [162]. Eight weeks of MBSR produced no structural brain change in 218 adults [163], and 18 months of meditation did not change regional brain volume in adults aged 65 or over [164] — brain-ageing protection is untested and should not be claimed. Slow breathing (under 10 breaths a minute, often about 6) reliably raises vagally mediated heart-rate variability across 223 studies [165] (STRONG physiology) and breathwork lowers self-reported stress (g −0.35 across 12 RCTs [166]; MODERATE, moderate risk of bias); five minutes a day of exhale-focused "cyclic sighing" for a month improved mood more than mindfulness meditation [167]. Direct cognitive benefits in healthy adults are thin — most HRV-biofeedback gains occurred in special populations [168] — so breathing is best framed as an acute de-arousal tool (LIMITED-EMERGING for cognition).

### *3.10 Detachment after work is the strongest recovery correlate*

Off-job recovery is the most consistently evidenced psychological correlate of sustained capacity across a working week. In 38,124 employees, psychological detachment from work during off-job time correlated with less exhaustion, better sleep, less fatigue, more positive affect and better task performance (small-to-medium effects), but *negatively* with creativity and contextual performance [169]; in 26,592 employees detachment had the strongest negative relationship with fatigue of all recovery experiences [170]. Low evening detachment predicted next-morning fatigue in 166 public-administration employees [171]; weekend detachment, relaxation and mastery predicted feeling recovered and better weekly task performance [172]; in 55 entrepreneurs, both challenge and hindrance stressors inhibited evening detachment through problem-solving pondering and affective rumination, which predicted next-morning well-being [173]; and coworker-rated performance peaked at *medium* detachment [174]. Detachment is trainable — 30 intervention studies raised it by d 0.36, more so with longer, higher-dose programmes [175] — but no RCT has shown that raising detachment causally lowers fatigue or improves cognition. Vacations improved well-being (d +0.43) with fast fade-out (d −0.38) in an early meta-analysis [176], a 2025 meta-analysis of 32 studies found larger and more durable effects, strongest with detachment and physical activity on holiday [177], and an app-based programme cut post-vacation work rumination (d −0.67) in 190 workers [178]. Grades: detachment and lower fatigue MODERATE to STRONG association (the lower grade reflects the correlational designs and the contrary signal for creativity and contextual performance); detachment interventions MODERATE; a causal effect of raising detachment on fatigue, performance or cognition not established; recovery and performance MODERATE association; vacations MODERATE (fade-out contested); objective cognitive outcomes untested (M-SHORT, PERFORMANCE).

### *3.11 Sleep and other healthy behaviours do not substitute for one another*

Healthy behaviours do not simply offset each other. In the English Longitudinal Study of Ageing, higher physical activity did not protect against the cognitive disadvantage of habitual sleep under 6 hours: active short sleepers declined faster and, after 10 years, matched the inactive groups, a difference of 0.20 SD at baseline age 50, 0.11 SD at age 60 and non-significant at age 70 [179] (LIMITED-EMERGING). At the day level, 30 extra minutes of moderate-to-vigorous activity predicted better next-day episodic memory (+0.15 SD) and working memory (+0.16 SD), while at least 6 hours of sleep independently predicted better episodic memory (+0.60 SD, imprecise) in 76 adults aged 50–83 [180] (LIMITED-EMERGING, PERFORMANCE). For people who train hard but sleep little, sleep therefore needs attention as a separate pillar rather than being treated as compensated for by exercise.

### *3.12 Summary of graded components*

Figure 1 maps the evidence grade of each component across the three time horizons, and Figure 2 compares reported effect sizes for selected components. Table 1 summarises the headline findings.

## 4. Discussion

### *4.1 Principal findings*

Across sleep, stress and recovery, the components with the largest and best-replicated effects on day-to-day thinking are subtractive: not accumulating sleep debt, not working through acute stress, anxiety or exhaustion, and being able to detach from work in the evenings and at weekends. Cumulative sleep restriction, acute total sleep loss and insomnia have the strongest evidence for performance; burnout, rumination and failure to detach are the clearest signals for sustained capacity across the working week.

The long-horizon picture is more modest than popular messaging suggests. Sleep regularity, objective fragmentation, habitual duration around 7 hours, depression and chronic stress track brain health over decades in many cohorts, but lagged analyses and MR studies repeatedly show that part of each association reflects early disease changing the behaviour rather than the reverse. Claims that improving these behaviours prevents dementia are not supported by the evidence reviewed here.

### *4.2 The costs are under-felt*

A recurring finding is that these costs are poorly perceived. Subjective sleepiness levelled off while attention lapses continued to rise [8]; self-rated sleep quality largely failed to predict objective cognition [71]; and burned-out workers appear to compensate, so that output looks normal while efficiency drops [136]. Self-report alone is therefore likely to miss the problem it is meant to detect. Combined with the stable, trait-like differences between people in vulnerability to sleep loss [12], this argues for objective measures interpreted against each person's own baseline.

### *4.3 Implications for digital health tools and workplace programmes*

The grades above suggest the following principles for tools and programmes that aim to support cognitive performance in working adults. These are inferences from the evidence rather than tested recommendations.

- Estimate sleep obtained relative to individual need and track a rolling sleep debt with recovery guidance, instead of relying on felt sleepiness.
- Compare sleep regularity and objectively measured fragmentation with each person's own baseline, because regularity-index cut-offs depend on the processing algorithm.
- Do not present single-night REM or slow-wave percentages as brain-health scores.
- Screen for insomnia and offer a route to (digital) CBT-I, justified by next-day function and work outcomes rather than dementia prevention.
- Use repeated, brief ratings of stress, mood, exhaustion and detachment, with referral pathways for possible depression or anxiety. For long-term risk, persistence over months matters more than daily spikes.
- Present slow breathing and mindfulness as stress and de-arousal tools rather than cognitive enhancers, and avoid "optimal stress" messaging.
- Avoid claiming causal next-day cognitive gains from recovery tools, and avoid dementia-prevention or brain-age




**Fig. 1.** Evidence grades for sleep, stress and recovery components by time horizon. Each cell shows the grade for one component and horizon; ranges (for example, M–S) are coloured by the lower grade. Most long-term (M-LONG) grades describe associations rather than causal effects. Sources are listed in Supplementary Tables S1 and S2.

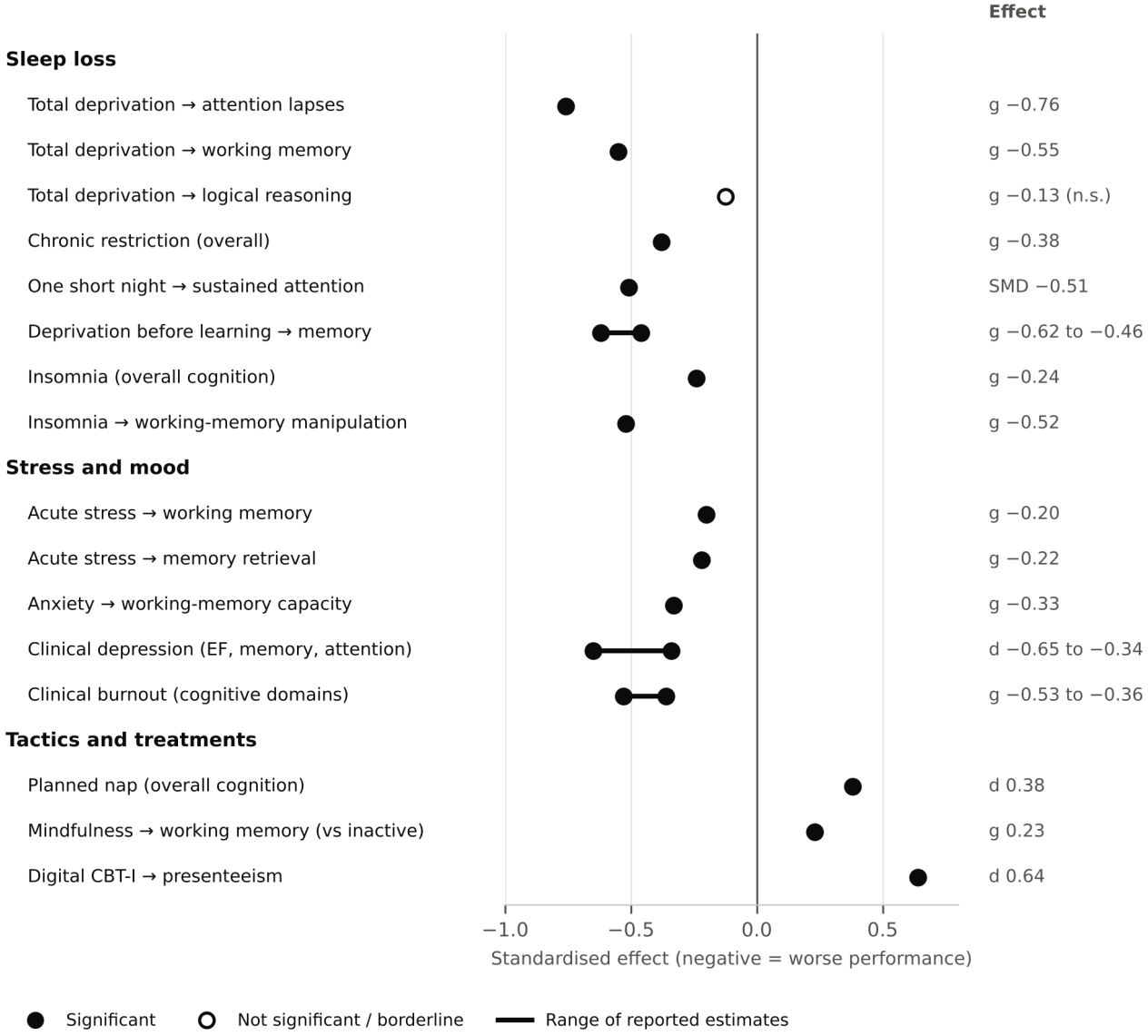



**Fig. 2.** Reported effect sizes for selected sleep, stress and recovery components. Values are pooled estimates from different meta-analyses and outcomes and are not directly comparable; negative values indicate worse performance. Filled circles are statistically significant and open circles are not; horizontal lines show the range of reported estimates (for example, before and after bias adjustment). Sources: [4,9,11,24,75,79,86,114,115,126–128,134,158].

claims.

### *4.4 Limitations*

This review has several limitations. First, it is a narrative rather than a systematic review: the search was not exhaustive, and no formal risk-of-bias assessment was performed for individual studies. Second, the four-level grading scale is study-specific and not equivalent to formal GRADE certainty ratings. Third, most performance evidence comes from young adults in laboratory settings and most long-term evidence from cohorts recruited after age 50, so transfer to working-age professionals and founders is an inference. Fourth, many long-horizon findings are observational and vulnerable to reverse causation and confounding. Fifth, publication bias affects several of the literatures reviewed, and pooled estimates without bias correction may overstate effects. Only English-language publications were included. Finally, the author is a founder of a company that develops products related to sleep, stress and recovery (see Competing interests).

### *4.5 Future research*

The central gap is that no trial has tested a combined sleep, stress and recovery programme on the objectively measured cognitive performance or productivity of working-age professionals or founders. Priorities include: randomised trials of detachment-building interventions with fatigue and cognitive outcomes; studies of sleep regularity and same-day performance in working adults; replication of the founder diary studies with objective cognitive probes; and evaluations of digital tools that use honest comparison conditions and pre-registered outcomes.

## 5. Conclusion

For working adults, the best-supported way to protect day-to-day thinking is to avoid losing it: to prevent cumulative sleep debt, to manage insomnia, acute stress and exhaustion, and to

**Table 1.** Summary of graded sleep, stress and recovery components. Full inventories with sources are given in Supplementary Tables S1 and S2.

| Component | Horizon | Grade | Headline effect |
|---|---|---|---|
| Cumulative sleep debt (consecutive nights $\leq$6 h) | PERF, M-SHORT | STRONG | 14 nights at 6 h $\approx$ one night of total sleep deprivation; restriction g $-0.38$ |
| Acute total sleep loss | PERF | STRONG | Attention lapses g $-0.76$; working memory $-0.55$; logical reasoning n.s. |
| Felt sleepiness as a gauge of impairment | PERF | MODERATE (under-reports) | Sleepiness plateaus while deficits keep rising |
| Recovery sleep after debt | M-SHORT | MODERATE | One 10-h night is incomplete; vigilance lags behind sleepiness |
| Protecting sleep before and after learning | PERF | STRONG (existence); MODERATE (size) | Before learning g 0.46–0.62; after learning 0.17–0.28 |
| Sleep loss $\rightarrow$ lower positive mood, higher anxiety | PERF, M-SHORT | STRONG | Positive affect SMD $-0.27$ to $-1.14$; anxiety $\approx$ 0.6 |
| Sleep regularity | M-LONG | MODERATE (association) | Least regular 5%: dementia HR 1.53 (U-shaped) |
| Objective sleep fragmentation | M-LONG | MODERATE (association) | Most fragmented third at age $\approx$40: poor processing speed OR 2.97 eleven years later |
| Wearable REM% / slow-wave % as brain-health markers | M-LONG | NULL-CONTRADICTED | No association with dementia in five pooled cohorts |
| Insomnia symptoms | PERF, M-SHORT | STRONG (association) | g $-0.24$; 7.8 lost workdays a year |
| Digital CBT-I | PERF, M-SHORT | MODERATE (work outcomes); LIMITED (objective cognition) | Presenteeism d 0.64 |
| Planned naps | PERF | STRONG (naps in general); LIMITED-EMERGING (<30-min rule) | d 0.38 overall; vigilance 0.61 |
| Long-term shift work | M-LONG | MODERATE | >10 years $\approx$ 6.5 years of cognitive ageing |
| Acute stress | PERF | MODERATE–STRONG | Working memory g $-0.20$; retrieval $-0.22$ |
| "Moderate stress boosts performance" | PERF | Unsupported | Induced stress lowers creativity, d $-0.20$ |
| Clinical depression; anxiety | PERF; M-LONG | STRONG (clinical depression, PERF); MODERATE association (M-LONG) | Depression d $-0.34$ to $-0.65$; anxiety and working memory g $-0.33$ |
| Clinical burnout | PERF, M-SHORT | MODERATE | g $-0.36$ to $-0.53$ across domains |
| Chronic stress; low job control | M-LONG | MODERATE association; LIMITED causal | Perceived stress and dementia HR 1.44 |
| Rumination | PERF, M-SHORT | MODERATE | Working-memory discarding r $-0.20$; stress $\rightarrow$ rumination $\rightarrow$ poor sleep |
| Mindfulness; slow breathing | PERF, M-SHORT | MODERATE (stress); STRONG (HRV); LIMITED (cognition) | Workplace stress g 0.56 vs mostly inactive controls |
| Evening and weekend detachment | M-SHORT | MODERATE–STRONG association; causal effect untested | Strongest correlate of lower fatigue among recovery experiences |

detach from work during off-job time. These costs are systematically under-felt, which makes objective, baseline-relative measurement more informative than self-report. It is reasonable to say that lost sleep and acute stress measurably impair same-day and next-day thinking, and that detachment and recovery go with less fatigue across the week. It is not yet possible to promise causal cognitive gains from recovery tools, or protection against dementia from any of these behaviours.

## Declarations

### *CRediT authorship contribution statement*

Vishwanath Kannan: conceptualisation, investigation, evidence grading, visualisation, writing – original draft, and writing – review and editing.

### *Declaration of competing interest*

The author is a founder of Adarna Inc., which develops wearable and software products for working professionals that relate to sleep, stress and recovery. No product of the company is evaluated in this review.

### *Funding*

This research received no external funding.

### *Data availability*

No new data were generated. All data discussed are available in the cited publications.

### *Declaration of generative AI and AI-assisted technologies in the writing process*

Generative AI tools, including Claude (Anthropic), were used in part to assist with identifying and summarising literature, structuring the manuscript, preparing figures and editing language. The author reviewed all AI-assisted content, checked every claim, figure and reference against the primary sources, and takes full responsibility for the content of this article. AI tools are not listed as authors.

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## Supplementary material

**Table S1.** Sleep component inventory

| Component | Horizon | Grade | Key effect, dose or threshold | Population | Key sources |
|---|---|---|---|---|---|
| Sleep obtained vs individual need; cumulative debt (consecutive nights $\leq$6 h) | PERF, M-SHORT | STRONG | Restriction g $-0.38$; 14 nights at 6 h $\approx$ 1 night of total deprivation; 4 h $\approx$ 2 nights | Lab adults 18–45 | [8,9] |
| Acute total sleep loss / $\geq$17 h awake | PERF | STRONG; alcohol equivalence MODERATE | Lapses g $-0.76$; working memory $-0.55$; reasoning n.s.; 17–19 h $\approx$ 0.05% BAC | Young lab adults; transport/army workers; physicians | [4,5,7] |
| One short night (2–6 h) | PERF | MODERATE | Sustained attention SMD $\approx$ 0.5; working memory and inhibition n.s. | Experimental adults | [11] |
| Felt sleepiness as a gauge of impairment | PERF | MODERATE (under-reports) | Sleepiness plateaus while deficits climb | Lab adults | [8] |
| Recovery sleep after debt | M-SHORT | MODERATE | One 10-h night incomplete; a weekend restores sleepiness, not vigilance | Young adults | [13,14] |
| Sleep banking / extension | PERF, M-SHORT | LIMITED-EMERGING (mixed) | +1–2 h helps short sleepers; null in two crossover RCTs | Cadets, students, older adults | [18,20, 21] |
| Protecting sleep before and after learning | PERF | STRONG (existence); MODERATE (size) | Before g 0.46–0.62; after 0.17–0.28 | Mostly students | [24,25] |
| Sleep loss $\rightarrow$ lower positive mood, higher anxiety | PERF, M-SHORT | STRONG | Positive affect SMD $-0.27$ to $-1.14$; anxiety $\approx$ 0.6 | Ages 7–79 | [28] |
| Sleep $\rightarrow$ venture ideation, innovation, leadership behaviour | PERF | LIMITED-EMERGING | Within-person diary links; one randomised deprivation experiment | 55–121 founders; leaders | [34,35, 38] |
| Extended shifts / cumulative long days | PERF | STRONG (impairment); cutting extended shifts MODERATE (sleep, attention), conflicting replication for errors | $\geq$5 extended shifts a month: OR 7.5 for fatigue errors | Physicians | [47,48] |
| Habitual duration (long term) | M-LONG | MODERATE association; causal LIMITED to CONTRADICTED | Lowest risk $\approx$ 7 h (6.4–7.8); $\leq$6 h at 50: HR 1.22; MR null | Whitehall II; UK Biobank | [52,54] |
| Drift toward long sleep ($\geq$9 h) | M-LONG | Conflicting (marker vs cause) | Short$\rightarrow$long RR 1.94 | Cohorts, mostly $\geq$50 | [60] |
| Sleep regularity | M-LONG; PERF | MODERATE (M-LONG); LIMITED (PERF) | Least regular 5%: dementia HR 1.53 (U-shaped) | UK Biobank, mean 62; undergraduates | [61,63] |
| Objective sleep fragmentation | M-LONG | MODERATE (association) | Top tertile, 11 y later: poor processing speed (DSST) OR 2.97; fluency OR 2.42; MoCA OR 2.29; Stroop n.s. | CARDIA, age $\approx$ 40 | [66] |
| 24-h rest-activity rhythm strength | M-LONG | MODERATE (association) | Dementia or MCI: HR 1.23 per SD lower relative amplitude; 1.32 per SD lower cosinor amplitude; day-to-day stability null | UK Biobank 43–79 | [68] |
| Wearable REM% / SWS% | M-LONG | NULL-CONTRADICTED | No association in 5 pooled cohorts | $\geq$60 | [69] |
| Self-rated sleep quality $\rightarrow$ objective cognition | PERF | LIMITED (largely null) | Bayes factors favour null | Students | [71] |
| Insomnia symptoms | PERF, M-SHORT | STRONG (association) | g $-0.24$; working-memory manipulation $-0.52$; 7.8 lost workdays/yr | Clinical samples; 7,428 workers | [75,77] |
| Digital CBT-I | PERF, M-SHORT | MODERATE (daytime function, work); LIMITED (objective cognition) | Presenteeism d 0.64; fatigue d $\approx$ 0.7 | Employees 23–56; adults mean 48 | [79–81] |
| Insomnia $\rightarrow$ dementia | M-LONG | LIMITED-EMERGING to MODERATE association; contested | RR 1.13–1.43; MR mostly null | Mostly older adults | [84] |
| Planned naps (in general); the <30-min rule | PERF | STRONG (naps); LIMITED-EMERGING (<30 min specifically) | d 0.38 (vigilance 0.61); working-age ES 0.18 with mean nap ~55 min; no moderation by nap length | Lab; working-age | [86–88] |
| Sleep-inertia management | PERF | MODERATE | Wait 15–30 min ($\geq$1 h after sleep loss); naps <30 min | Lab | [89] |
| Habitual napping (long term) | M-LONG | Conflicting / LIMITED | Protective vs OR 1.35 (naps >30 min) vs null | Mean age $\geq$56 | [91] |
| Chronotype-synchrony scheduling | PERF | LIMITED (mixed) | Synchrony in 45% of studies of 18–45-year-olds | Adults | [93] |
| Long-term shift work / circadian misalignment | M-LONG | MODERATE | >10 y $\approx$ 6.5 y of cognitive ageing; $\geq$5 y to recover | Workers 32–62 | [97] |
| Frequent long-haul travel | M-SHORT, M-LONG | LIMITED-EMERGING | $\geq$21 nights/month: PR 1.37–2.27 for sleep, anxiety, depression symptoms | Cabin crew; corporate clients | [100,101] |
| Daytime light, dark nights | M-SHORT | MODERATE (circadian, mood); LIMITED (cognition) | $\geq$250 lux by day; $\leq$10 lux from 3 h before bed | UK Biobank 37–73; consensus panel | [102,103] |
| Night-mode filters, blue-blocking glasses | M-SHORT | NULL-CONTRADICTED / very low certainty | No sleep difference | Young adults; adults | [106,107] |
| Wind-down, worry offload, avoiding bedtime procrastination | M-SHORT | LIMITED to MODERATE | Programmes g $-0.54$; 5-min to-do list | Adults 18–64; students | [109,110] |

**Table S2.** Stress, mood and recovery component inventory

| Component | Horizon | Grade | Key effect, dose or threshold | Population | Key sources |
|---|---|---|---|---|---|
| Acute stress state $\rightarrow$ working memory, retrieval | PERF | MODERATE–STRONG | g $-0.20$ (WM); $-0.22$ (retrieval); NA effect 0–10 min, cortisol from ~25 min (hypothesis) | Lab adults 18–29 | [114,115] |
| Acute stress $\rightarrow$ risky decisions | PERF | MODERATE | d 0.17–0.26; delay discounting null | Lab adults | [116,117] |
| Morning stress anticipation | PERF | LIMITED-EMERGING | Predicts same-day WM | 240 adults 25–65 | [119] |
| "Moderate stress boosts performance" | PERF | Unsupported (no direct evidence) | Induced stress lowers creativity d $-0.20$ | Lab | [122,123] |
| Stress reappraisal prompts | PERF | LIMITED to MODERATE | d 0.14 after bias correction | Mean age 22.6 | [124] |

*(continued)*

| Component | Horizon | Grade | Key effect, dose or threshold | Population | Key sources |
|---|---|---|---|---|---|
| Depressive symptoms | PERF, M-SHORT; M-LONG | STRONG (clinical, PERF); MODERATE association, contested (M-LONG) | d −0.34 to −0.65; dementia RR 2.25; treated vs untreated HR 0.70 | Clinical MDD; UK Biobank 50–70 | [126,129] |
| Anxiety | PERF; M-LONG | MODERATE–STRONG (PERF); LIMITED (M-LONG) | WM capacity g −0.33 | N = 22,061 | [128] |
| Clinical burnout / exhaustion | PERF, M-SHORT | MODERATE (clinical); LIMITED (non-clinical) | g −0.36 to −0.53 across domains | Burnout patients | [134] |
| Chronic / persistent stress | M-LONG | MODERATE association; LIMITED causal | HR 1.44; dose by persistence 1.10 → 2.51 | Midlife cohorts | [137,138] |
| Low job control / passive work | M-LONG | MODERATE | Passive RR 1.15; strain 1.21; passive vs active HR 1.58 | Workers | [141,143] |
| Challenge vs hindrance stressors (founders) | M-SHORT | MODERATE | Challenge ↑ performance; hindrance ↓ well-being | Entrepreneurs | [145] |
| Rumination / worry | PERF, M-SHORT | MODERATE (WM discarding, sleep pathway); LIMITED (inhibition/shifting) | r −0.20; stress → rumination → poor sleep | Mixed | [148,152] |
| Expressive writing | PERF; M-SHORT | Pre-task writing NULL-CONTRADICTED; WM LIMITED; distress small | Distress g −0.12 | Students; adults | [153,155] |
| Activating positive mood → creativity | PERF | MODERATE | r 0.15 | Students and adults | [157] |
| Mindfulness → cognition | PERF | LIMITED to MODERATE | g 0.15–0.39; not superior to active controls | Mixed adults | [158,159] |
| Mindfulness → work stress | M-SHORT | MODERATE (vs inactive) | Stress g 0.56; distress 0.69 | Employees | [160] |
| Meditation → brain ageing | M-LONG | Untested; short-term structure NULL | No MRI change after 8 weeks or 18 months | Adults; ≥65 | [163,164] |
| Slow breathing / breathwork | PERF, M-SHORT | STRONG (HRV); MODERATE (stress); LIMITED (cognition) | ~6 breaths/min; 5 min/day; stress g −0.35 | Healthy adults | [165,166] |
| Evening/weekend psychological detachment | M-SHORT, PERF | STRONG to MODERATE association (fatigue; grades differ by reading); contrary signal for creativity; causal untested | Strongest negative link to fatigue; medium detachment best for performance | 38,124 employees; founders | [169,170] |
| Detachment-building interventions | M-SHORT | MODERATE | d 0.36 on detachment | 3,725 workers | [175] |
| Vacations / time off | M-SHORT | MODERATE (fade-out contested) | d +0.43; fades within ~1 month in teachers | Employees | [176,177, 181] |