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The Association of Hydration Status and Other Occupational Factors with Attention, Concentration, and Working Memory among Mine Workers

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Abstract

Background: Hot work environments and poor hydration status may impair workers' cognitive functions, particularly attention, concentration, and working memory, increasing the risks of operational errors and unsafe behaviors. In open-pit coal mining, heat exposure, high workload, and operational demands contribute to elevated incident rates.
Objective: This study aimed to examine the association between hydration status and occupational factors with attention, concentration, and working memory among mine workers at PT. X.
Methods: This analytic observational study employed a cross-sectional design among 90 morning-shift coal miners at PT. X, East Kalimantan, recruited using convenience sampling. Cognitive function was assessed using the Digit Span Test, with the Forward Digit Span (FDS) subtest assessing attention and concentration and Backward Digit Span (BDS) subtest assessing working memory. Hydration status was assessed using Urine Specific Gravity (USG) to determine hydration trends over three consecutive days, and perceived stress was measured using the Perceived Stress Scale-10 (PSS-10).
Results: The result showed significant associations between hydration status and attention and concentration (p=0.023), as well as working memory (p=0.019). Job type, workload, and work climate were also significantly associated with attention, concentration, and working memory. No change in hydration status trends were observed during the three-day measurement period, with a consistent median USG value of 1,018, indicating mild dehydration.
Conclusion: Hydration status, job type, workload, and hot work climate were significantly associated with attention, concentration, and working memory, whereas age, sex, health status, and perceived stress did not show consistent associations with cognitive outcomes.
Keywords: hydration status, USG, Digit Span Test, cognitive function, hot work environment

Abstrak

***Latar Belakang**: Iklim kerja panas dan status hidrasi yang buruk dapat menurunkan fungsi kognitif pekerja, terutama atensi, konsentrasi, dan memori kerja, sehingga meningkatkan risiko kesalahan operasional dan perilaku kerja tidak aman. Pada pertambangan batubara metode tambang terbuka, pajanan panas, beban kerja tinggi, dan tuntutan operasional berkontribusi terhadap tingginya insiden kerja.*
***Tujuan**: Penelitian ini bertujuan untuk mengetahui hubungan antara status hidrasi dan faktor okupasi terhadap fungsi atensi, konsentrasi, dan memori kerja pada pekerja tambang PT. X*
***Metode**: Penelitian ini menggunakan metode analitik observasional dengan desain potong lintang analitik. Sampel penelitian adalah 90 pekerja tambang batubara shift pagi yang diambil menggunakan teknik convenience sampling. Instrumen penelitian yang digunakan adalah Digit Span Test dengan subtes Forward Digit Span (FDS) untuk menilai atensi dan konsentrasi, serta subtes Backward Digit Span (BDS) untuk menilai memori kerja. Urine Spesific Gravity (USG) untuk menilai status hidrasi dan melihat tren status hidrasi yang dilakukan selama tiga hari berturut-turut dan Perceived Stress Scale (PSS) untuk menilai persepsi stres.*
***Hasil**: Hasil penelitian menunjukkan bahwa **t**erdapat hubungan antara status hidrasi dengan atensi dan konsentrasi (p=0.023) serta memori kerja (p=0.019). Jenis pekerjaan, beban kerja, dan iklim kerja juga menunjukkan hubungan signifikan terhadap atensi, konsentrasi, dan memori kerja. Tidak ditemukan perubahan tren status hidrasi selama tiga hari pengukuran, dengan nilai median USG yang konsisten sebesar 1,018, yang menunjukkan kondisi dehidrasi ringan.*
***Kesimpulan**: Status hidrasi, jenis pekerjaan, beban kerja, dan iklim kerja panas berhubungan signifikan terhadap atensi, konsentrasi, dan memori kerja, sedangkan usia, jenis kelamin, status kesehatan, dan stres yang dirasakan tidak menunjukkan hubungan yang konsisten dengan luaran.*
***Kata kunci:** status hidrasi, USG, Digit Span Test, fungsi kognitif, iklim kerja panas*

Introduction

Heat stress represents a primary factor impairing cognitive function among workers, particularly in extreme exposure environments such as open-pit coal mining. Open-pit coal mining involves substantial occupational risks, particularly exposure to heat stress and high physical and mental workloads, which may lead to fatigue and impair workers' alertness, concentration, and reaction time, thereby increasing the risk of occupational accidents and reducing productivity.[1] Studies indicate most miners commence shifts in a dehydrated state, with mean urine specific gravity of 1.024.[2] Mild dehydration has been shown to reduce sustained attention, response speed, and working memory capacity through plasma osmolality changes and prefrontal cortex neurotransmitter disruption.[3]

International Labour Organization reports approximately 70% of the world's 2.4 billion workers experience occupational heat exposure, resulting in 22.85 million non-fatal accidents and 18,970 heat-related deaths.[4] PT. X is an open-pit coal mining company with multiple project sites located in Kalimantan, that operates continuously 24 hours a day under a rotating work system with two 12-hours shifts, potentially exacerbating these exposures. At PT. X, 136 work incidents were recorded throughout 2024, causing material losses and injuries to 8 workers.

Attention, concentration, and working memory constitute critical cognitive aspects in complex mining operations. Impairments in these functions can affect decision-making and elevate accident risks.[5] This study aims to identify associations between hydration status and other occupational factors with attention, concentration, and working memory among PT. X miners to develop effective mitigation strategies.

Methods

This analytic observational study with a cross-sectional design was conducted at PT. X Delta site, East Kalimantan, Indonesia, from December 2025 to January 2026. Measurements of dependent variables (attention, concentration, working memory) and independent variable (hydration status) were performed simultaneously at the end of morning shifts (18:30). The study site is an open-pit coal mining operation characterized by high heat exposure, heavy physical work demands, and safety-critical tasks requiring sustained cognitive performance. Data collection was conducted at the end of the morning shift to capture the cumulative effects of occupational and environmental exposure. Work climate was assessed using the Wet Bulb Globe Temperature (WBGT) index.

The accessible population comprised coal miners at PT. X Delta site, East Kalimantan, who were assigned to the morning shift (06:00–18:00). Participants were recruited using convenience sampling, with a total sample size of 90 workers. This study used convenience sampling because this approach enables rapid and pratical participant recruitment among mining workers who face limited accessibility, rotating work schedules, and operational demands, thereby allowing the collection of sufficient data in accordance with field conditions and the study objectives.

Inclusion criteria consisted of permanent or contract employees at the Delta site who worked the morning shift, had been on site for at least one week prior to data collection, and provided written informed consent. Exclusion criteria included workers who were off duty during data collection, had a history of hearing or psychiatric disorders based on the 2025 Medical Check-Up (MCU) records, experienced clinical symptoms such as vomiting or diarrhea within the preceding 24 hours, or had consumed diuretic medications or alcoholic beverages within 24 hours prior to assessment. This study has received approval from the Research Ethics Committee of the Faculty of Medicine, University of Indonesia, with approval number KET-1777/UN2.F1/ETIK/PPM.00.02/2025.

Data Collection Procedures

Data collection followed a standardized procedure, beginning with the acquisition of official research approval and access to the 2025 MCU records from PT. X management. Environmental work climate was assessed using WBGT instrument for 30 minutes at mid-shift to evaluate heat exposure conditions at each work location. Eligible participants were screened based on the predefined inclusion and exclusion criteria before providing written informed consent and receiving a detailed explanation of the study procedures.

Attention, concentration, and working memory were assessed using the Digit Span Test, administered verbally by trained researchers at the end of the shift in

a quiet environmental with minimal distractions. The forward digit span (FDS) subtest was used to evaluate attention and concentration, while the backward digit span (BDS) subtest assessed working memory. Participants were given standardized instructions and practice trials prior to the formal assessment. The test was administered by reading a sequence of numbers to the participants at a constant pace, after which they were asked to repeat the numbers in the same order (Forward Digit Span) and in reverse order (Backward Digit Span). The length of the digit sequence was gradually increased until the participant was unable to recall the sequence correctly, and the score was determined based on the longest correctly recalled sequence. Digit Span was selected because it is practical, does not require special equipment or specialized training, is independent of literacy level, and has a short administration time, making it suitable for data collection among mining workers. Moreover, Digit Span spesifically assesses attention, concentration, and working memory, which are highly relevant to the demands of mining work. However, the use of this instrument also represents a limitation of the study, as it does not assess global cognitive function, potentially leading to an underestimation of the true cognitive impact.

Following the Digit Span Test, participants completed a general demographic questionnaire and the Perceived Stress Scale-10 (PSS-10) using paper-based forms. Urine specimens were colleted after participants completed all questionnaire. Participants were provided with urine containers at the end of each shift for three consecutive days to collect daily urine samples. Hydration status was determined based on Urine Spesific Gravity (USG), measured using a urine refractometer within two hours of sample collection to minimize specimen degradation and measurement error.

Main Measurements

Hydration status was objectively assessed through Urine Specific Gravity (USG) measured via portable refractometer, categorized as non-dehydrated (≤1.015), mild dehydration (1.016-1.020), moderate dehydration (1.021-1.025), severe dehydration (1.026-1.030), and clinical dehydration (≥1.030).[2] Cognitive function was evaluated using the Digit Span Test from the Wechsler Adult Intelligence Scale. Forward digit span (FDS) scores represented attention and concentration, while backward digit span (BDS) scores measured working memory. Both tests demonstrated established validity for occupational cognitive assessment.[6] The USG measurements was performed at the end of the morning shift using a spot urine sample. There was no restriction on fluid intake prior to the examination, as changes in urine osmolality and specific gravity do not occur instantaneously but rather through renal filtration and reabsorption processes. Consequently, alterations in urine concentration are generally detectable within approximately 60 minutes, depending on the volume of fluid consumed, baseline hydration status, and individual activity level.[7,8]

Other variables assessed included age dichotomized at 40 years (≤40/>40), sex (male/female), education level (high school/≥diploma), perceived stress using PSS-10 (mild/moderate/high), health status from 2025 MCU records (healthy/unhealthy), job type (office/field worker), workload classified per Indonesian Ministerial Regulation 70/2016 (light/moderate/heavy/very heavy), and work climate using WBGT (<28°C normal/≥28°C high). In the bivariate analysis, category simplification was applied to several variables, including hydration status, stress level, and workload. The categories were combined based on methodological considerations and data distribution. Some categories contained relatively small numbers of subject, which could result in unstable estimates. Additionally, category simplification was performed to facilitate interpretation of the results and to improve the clarity of the associations between independent and dependent variables.

Data were analyzed using IBM SPSS version 25. Univariate analysis was conducted to described participant characteristics and outcome variables, with results reported as median values. Normality testing guided the selection of subsequent analyses. Bivariate analysis examined associations between independent variables and cognitive outcomes (FDS and BDS scores) using Mann-Whitney U tests for non-normally distributed data, with statistical significance set at $p<0.05$.

Results

This study involved 90 workers, the majority of whom were male (93,3%) and age ≤40 years (74,4%). Most participants had a high school level education (67,8%), worked as field workers (63,3%), were in good health

Table 1. Characteristics of the study subjects

Variable	Frequency (n)	Persentage (%)	Median (min – max)
Digit Span Test			
Forward Digit Span (FDS)			6 (3 – 9)
Backward Digit Span (BDS)			4 (3 – 8)
Age			
≤40 years	67	74,4	
>40 years	23	25,6	
Gender			
Female	6	6,7	
Male	84	93,3	
Education Level			
High (≥ Diploma)	29	32,2	
Low (≤ High School)	61	67,8	
Job Type			
Office worker	33	36,7	
Field worker	57	63,3	
Health Status			
Healthy	83	92,2	
Unhealthy	7	7,8	
Workload			
Light	35	38,9	
Moderate	28	31,1	
Heavy	19	21,1	
Very heavy	8	8,9	
Stress			
Mild	25	27,8	
Moderate	64	71,1	
High	1	1,1	
Work Climate			
Normal (<28°C)	33	36,7	
High (≥28°C)	57	63,3	

(92,2%), reported moderate perceived stress (71,1%), were exposed to a hot work climate (63,3%), and had a light workload (38,9%). The median FDS score was 6 and the median BDS score was 4. The minimum score for both tests was 3, while the highest scores were 9 for FDS and 8 for BDS**.**

The average USG values did not demonstrate any change in hydration trends from the first to the third day of measurement (Figure 1). The stable median USG values of 1,018 over three consecutive days indicates persistent mild dehydration among morning shift coal mine workers at the Delta site of PT. X. This consistent pattern demonstrates chronic hydration imbalance throughout the work shift, with no recovery observed between measurement days despite standard rest periods.

Bivariate analysis was conducted to determine the relationship between hydration status, demographic factors, and occupational factors with attention, concentration, and working memory, measured using forward and backward digit span, among PT. X mine workers (Tables 2-3). Significant associations were identified for hydration status with both FDS (p=0.023) and BDS (p=0.019), alongside job type, workload, and work climate. These findings highlight the consistent impact of hydration and occupational factors on attention, concentration, and working memory, with field workers and hot work climates showing the

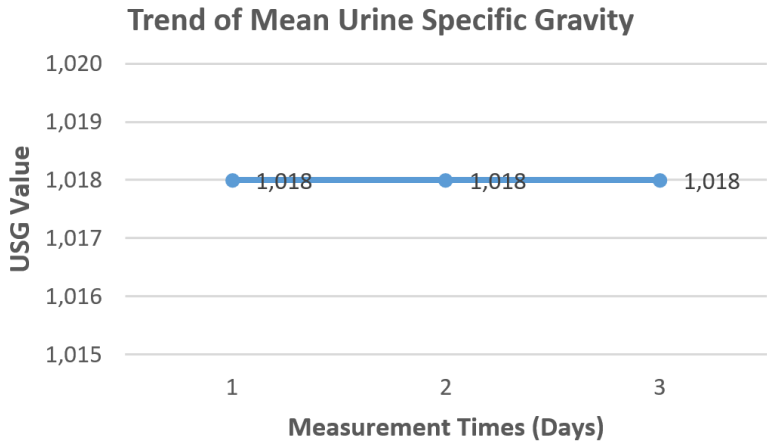

Figure 1. Trend of mean urine spesific gravity among workers

strongest bivariate associations with reduced cognitive performance. The median FDS score was lower among dehydrated workers (5) compared with non-dehydrated workers (6). Similarly, the FDS mean rank was lower among dehydrated workers (41.20) compared to non-dehydrated workers (53.68). Higher median FDS scores were found among workers with high education (6), office worker job type (6), light workload (6), and normal work climate (6), with higher median FDS scores observed among workers with higher education (6), office-based job types (6), light workloads (6), and normal work climates (6).

Based on Table 3, a significant association was observed between hydration status and working memory, as measured by BDS (p=0.019). Although the median BDS scores were the same for dehydrated workers (4) and non-dehydrated workers (4), the BDS mean rank was lower among dehydrated workers (41.10) compared to non-dehydrated workers (53.87). Demographic and occupational factors significantly associated with attention, concentration, and working memory among PT. X mine workers included job type, workload, and work climate. Higher median BDS scores were observed among workers with higher education (5), office-based job types (5), light workloads (5), and normal work climates (5).

In this study, the analysis was limited to the bivariate level and was not extended to multivariate analysis. This approach was aligned with the primary objective of the study, which was to explore the associations between hydration status and other factors with attention, concentration, and working memory, rather than to identify the most dominant predictors. Furthermore, the results of assumption testing indicated that the data did not meet the requirements for linear regression analysis, as evidenced by non-normal residual distribution and the presence of multicollinearity among independent variables. Therefore, conducting multivariate analysis was considered likely to produce biased and less valid estimates, and consequently, it was not performed in this study.

Discussion

The descriptive profile of this study indicates that 74.4% of workers were aged ≤40 years, 93.3% were male, 67.8% had a low educational level (≤ high school), and 63.3% were field workers exposed to hot working conditions (WBGT >28°C). These characteristics represent a typical demographic pattern among manual workers and may influence cognitive performance. Lower educational attainment is associated with reduced cognitive reserve, which can diminish the efficiency of the prefrontal cortex in tasks involving attention and working memory.[9] Field-based work combined with heat exposure may further induce impairments in neurovascular coupling, leading to reduced cognitive performance through disruption of hippocampal–prefrontal pathways. This finding is consistent with Yeoman et al. (2022), who reported similar miner characteristics with mean FDS scores of 5.8 ± 1.4 and BDS scores of 4.6 ± 1.3.[1] In addition, Müller et al.

Table 2. The relationship between demographic and occupational factors and attention and concentration

Variable	*Forward Digit Span Score*		p
	Median (min – max)	Mean Rank	
Age			
≤40 years	6 (4 – 8)	46,92	0,353
>40 years	5 (3 – 9)	41,37	
Gender			
Female	6 (4 – 7)	47,92	0,804
Male	6 (3 – 9)	45,33	
Education Level			
High (≥ Diploma)	6 (5 – 9)	59,10	<0,001*
Low (≤ High School)	5 (3 – 8)	39,03	
Job Type			
Office worker	6 (4 – 9)	58,73	<0,001*
Field worker	5 (3 – 7)	37,84	
Health Status			
Healthy	6 (3 – 9)	46,11	0,417
Unhealthy	5 (5 – 7)	38,21	
Hidration Status			
Non-Dehydrated	6 (3 – 9)	53,68	0,023*
Dehydrated	5 (4 – 7)	41,20	
Work Load			
Light	6 (4 – 9)	56,83	0,001*
Moderate-very heavy	5 (3 – 7)	38,29	
Stress			
Mild	6 (5 – 9)	48,00	0,552
Moderate-high	6 (3 – 8)	44,54	
Work Climate			
Normal (<28°C)	6 (4 – 9)	58,73	<0,001*
High (≥28°C)	5 (3 – 7)	37,84	

Mann Whitney Test *Significant (p<0,05)

(2019), reported FDS scores of 5.2 and BDS scores of 4.1 under WBGT >30°C, attributing these declines to heat-induced prefrontal cortical hypoperfusion, which is consistent with the findings of the present study.[10]

The results of this study also indicate that workers' hydration status trends predominantly fell within the category of mild dehydration, as reflected by a median USG value of 1.018 over three consecutive days, which was significantly associated with reduced attention, concentration, and working memory among mine workers. This finding is consistent with the study by Friska et al (2023), who reported consistent moderate dehydration (median USG 1.020–1.021) over four consecutive days among aluminum foundry workers using comparable end-of-break USG measurements. That study confirmed the presence of occupationally related dehydration patterns in high-temperature industrial environments, and similar findings were observed in the present study.[11] The consistent median USG values indicating mild dehydration raise the question of whether the workers were experiencing chronic dehydration. Chronic dehydration is defined as sustained fluid loss over extended periods (>2 weeks) where fluid output consistently exceeds intake, leading

Table 3. The relationship between demographic and occupational factors and working memory

Variable	*Backward Digit Span Score*		P
	Median (min – max)	Mean Rank	
Age			
≤40 years	4 (3 – 8)	47,56	0,175
>40 years	4 (3 – 7)	39,50	
Gender			
Female	4,5 (4 – 7)	61,33	0,102
Male	4 (3 – 8)	44,37	
Education Level			
High (≥ Diploma)	5 (3 – 7)	62,21	<0,001*
Low (≤ SMA)	4 (3 – 8)	37,56	
Job Type			
Office worker	5 (4 – 8)	62,59	<0,001*
Field worker	4 (3 – 5)	35,61	
Health Status			
Healthy	4 (3 – 8)	46,61	0,141
Unhealthy	3 (3 – 7)	32,36	
Hidration Status			
Non-Dehydrated	4 (3 – 8)	53,87	0,019*
Dehydrated	4 (3 – 7)	41,10	
Workload			
Light	5 (3 – 8)	60,56	<0,001*
Moderate-very heavy	4 (3 – 5)	35,92	
Stress			
Mild	4 (3 – 7)	49,36	0,356
Moderate-High	4 (3 – 8)	44,02	
Work Climate			
Normal (<28°C)	5 (4 – 8)	62,59	<0,001*
High (≥28°C)	4 (3 – 5)	35,61	

Mann- Whitney Test *Significant (p<0.05)

to physiological adaptations such as blunted thirst sensitivity and renal sodium retention.[12] Its cognitive impacts include reduced concentration (15-20%), impaired working memory, and slowed reaction times (r=-0.45 to -0.62), increasing workplace accident risk under chronic heat exposure.[3,13] In this study, it could not be determined whether the workers were classified as having acute or chronic dehydration. However, several risk factors that may contribute to dehydration were identified, including field-based work, moderate-very heavy workload, and exposure to hot working conditions (WBGT ≥28°C). Limitations include: (1) short measurement duration (3 days vs. chronic threshold >14 days), (2) lack of pre-exposure baseline or 6-month hydration history, and (3) absence of chronic biomarkers like elevated serum osmolality (>295 mOsm/kg) or BUN/creatinine ratio (>20).[14] Confirmation requires longitudinal studies with >4-week serial measurements and comprehensive hematological parameters to distinguish physiological adaptation from chronic pathology.

This study identified a significant association between hydration status and cognitive performance as measured by the Digit Span test. In contrast, Friska et al (2023),

reported no significant relationship between USG and Concentration Grid Test (CGT) scores. Instead, fatigue, assessed using the Swedish Occupational Fatigue Inventory (SOFI), emerged as the primary predictor of impaired concentration.[11] This discrepancy may be explained by the fact that Digit Span is more sensitive to dehydration-related effects, as it assesses sustained attention and working memory, which are particularly vulnerable to changes in hydration status. Furthermore, Digit Span requires active information manipulation, resulting in a higher cognitive load that is more likely to show performance decrements under dehydrated conditions. Brake and Bates (2003) also documented stable elevations in USG, with a mean USG of 1.024, among industrial workers during prolonged work shifts.[2] This finding was attributed to cumulative sweat-related fluid losses exceeding ad libitum fluid intake, despite the availability of drinking water. The stability of end-of-shift USG occurs because renal osmolality adapts to hypovolemic conditions, thereby maintaining elevated urine concentration despite periods of recovery. This mechanism contrasts with acute dehydration, in which USG values typically improve following rehydration.[15]

The median FDS score of 5 and BDS score of 4 observed in this study fall within the normal range for healthy manual workers and miners exposed to occupational heat stress. Normative data from the Wechsler Adult Intelligence Scale–Fourth Edition (WAIS-IV) indicate that FDS scores of 4–6 and BDS scores of 3–5 are typical for adults engaged in physically demanding occupations, reflecting adequate attention, concentration, and working memory capacity under baseline conditions.[16] Similarly, Mousavi et al (2025), reported median FDS = 5.2 and BDS = 4.1 among field workers in hot environments, with no significant cognitive impairment compared with controls, attributing the preserved performance to adaptive neurocognitive resilience despite physiological heat strain.[17] These findings are consistent with industrial normative benchmarks, in which healthy miners demonstrate mean FDS = 5.3 (SD = 1.1) and BDS = 4.2 (SD = 1.0) during shift work, confirming that the scores observed in the present study represent normal cognitive function adequate for mining safety demands.[18]

The significant bivariate association between hydration status and both FDS and BDS observed in this study strongly supports the theory proposed by Ganio et al (2011), that mild dehydration can impair sustained attention and working memory through reduced cerebral blood flow and hypoactivation of the prefrontal cortex. Physiologically, dehydration increases plasma osmolality, which activates hypothalamic osmoreceptors, thereby inducing cerebral hypoperfusion and disrupting neurotransmitter homeostasis, particularly the synthesis of dopamine and acetylcholine in the dorsolateral prefrontal cortex, a region that plays a critical role in sustained attention and working memory manipulation.[3] Zhang et al (2019), experimentally demonstrated this mechanism in a controlled trial, in which dehydration significantly reduced FDS, BDS, and Total Digit Span scores, with full cognitive recovery occurring within one hour after rehydration as brain hydration and neurochemical balance were restored.[6]

Although educational level showed statistical significance, it was treated as a confounding variable that may influence the estimation of the primary association. Bivariate analysis identified office worker job type, light workload, and normal work climate as protective factors against attention, concentration, and working memory, as indicated by significant differences in mean rank values. Exposure to hot work climates may induce heat strain, leading to reduced vigilance, slower reaction speed, and decreased cognitive accuracy, thereby increasing the risk of heat-related illnesses and occupational accidents in the mining industry.[19] These findings indicates that field-based work, occupational heat exposure, and moderate-to-heavy workloads may adversely affect cognitive performance, particularly attention, concentration, and working memory. Overall, these findings emphasize that maintaining attention, concentration, and working memory among mine workers in hot work environments depends not only on controlling work climate and workload, but more importantly on improving hydration status and enhancing cognitive capacity through education and training. Therefore, intervention programs at PT. X should prioritize structured hydration promotion strategies and worker competency strengthening to minimize the risk of cognitive performance decline during working hours. Such interventions may include the implementation of comprehensive workplace hydration management programs, provision of easily accessible drinking water, education on the early signs of dehydration and cognitive decline, and scheduled rest breaks during peak heat periods.

Limitations

This study had several limitations related to time constraints and examiner availability. Data collection was conducted in the evening after participants completed the morning shift, at their respective dormitory locations, with workers typically arriving between 18:30 and 19:00. The assessments procedures, which included the Digit Span Test, questionnaire completion, and urine specimen collection, were time consuming and encroached upon participants' evening rest periods. Data collection was carried out solely by the principal investigator with assistance from one site physician who had been previously trained by the principal investigator. In addition, the dispersed locations of the workers' dormitories further increased the time required for data collection. These factors resulted in prolonged waiting times, which may have reduced some participants' motivation to take part in the study.

Furthermore, attention, concentration, and working memory were not categorized, precluding the assessment of their clinical significance. Cognitive function was not comprehensively evaluated due to limitations of the measurement instruments, which may led to an underestimation of the true magnitude of the observed effects. In addition, hydration status was assessed only in the post-shift period to capture cumulative occupational exposure during the shift. However, the absence of pre-shift measurements limited differentiation between occupationally induced and pre-existing dehydration.

Conclusion

This study demonstrated that no changes in hydration status trends were observed among PT. X mine workers, with a consistent median USG value of 1.018, indicating mild dehydration. This was evidenced by stable median USG values without significant differences across the first, second, and third measurement days. Hydration status was shown to be significantly associated with attention, concentration, and working memory among PT. X mine workers. Bivariate analysis revealed significant associations between hydration status and cognitive performance, as measured by forward and backward digit span, with dehydrated workers exhibiting lower digit span scores compared with non-dehydrated workers. In addition to hydration status, several other factors were also associated with attention, concentration, and working memory among PT. X mine workers. Bivariate analysis indicated that job type, workload, and hot work climate were significantly associated with attention, concentration, and working memory, as demonstrated by forward and backward digit span scores, whereas age, sex, health status, and perceived stress did not show consistent associations with cognitive outcomes.

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