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Chapter- 15

A Scoping Review on the Effects of Psychological Stress on Working Memory: Insights into Sustainable Development Through Mental Health

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Abstract:
Sustainable development is essential for the preservation of natural resources. A total of 17 Sustainable Development Goals (SDGs) have been adopted by the United Nations, with the third goal focusing on promoting health and well-being. Mental health is an inseparable part of overall health; therefore, mental well-being is crucial for an individual's well-being. If mental well-being is compromised, it can lead to mental disorders such as depression, anxiety, and stress. It is well-known that mental illness can alter the structure of various parts of the brain, such as the hippocampus and amygdala, which are involved in memory processes. Psychological stress is often the initial phase of mental illness. Investigators have reported inconsistent findings on the effect of psychological stress on working memory. While most studies have shown that psychological stress negatively affects working memory, a few reports have indicated no relationship or even a positive relationship between the two. In India, there is a lack of evidence in the literature addressing the relationship between psychological stress and working memory. More research is needed to fully understand psychological stress's impact on working memory. Psychological stress management programs are necessary to prevent long-term mental illness. Additionally, mental health policies should be formulated to promote mental well-being. Ultimately, mental wellness will contribute to improved socio-economic conditions in any country.

Introduction:

Sustainable development can be defined in many ways. According to the International Institute for Sustainable Development, sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (International Institute for Sustainable Development, 2024; Saha, 2023; Moitra et al., 2023; Mukherjee et al., 2022; Chatterjee et al., 2023). Among the 17 Sustainable Development Goals (SDGs) adopted by the United Nations, the third goal is to "ensure healthy lives and promote well-being for all at all ages" (United Nations, 2024). Sustainable Development Goal 3 (SDG 3) aims to promote health and well-being (World Health Organization, 2024b). Overall health includes both physical and mental health (Centers for Disease Control and Prevention,

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2024). Mental health is an essential and integral part of human well-being, without which overall well-being cannot be achieved (World Health Organization, 2024a).

Mental illnesses include conditions such as depression, attention deficit hyperactivity disorder (ADHD), autism, and obsessive-compulsive disorder (OCD) (National Institutes of Health (US) & Biological Sciences Curriculum Study, 2007). Research on patients with mental illness has revealed that mental illness can alter the structure of different parts of the brain (National Institutes of Health (US) & Biological Sciences Curriculum Study, 2007; Dixit et al., 2024; Sapharina et al., 2024). The hippocampus and amygdala are brain regions that play a major role in memory. Reduced hippocampal volume and hyperactivity of the amygdala have been observed in adults with depression (Dillon and Pizzagalli, 2018). It has also been observed that patients with depression secrete less serotonin in the synaptic cleft compared to individuals without depression (National Institutes of Health (US) & Biological Sciences Curriculum Study, 2007). Serotonin plays an important role in working memory (Cano-Colino et al., 2013). Therefore, individuals with depression are prone to experiencing a decline in memory function (Dillon and Pizzagalli, 2018). The current review aims to examine the effect of psychological stress on the working memory of young adults.

Methodology:

The PubMed database was searched using keywords such as ‘mental health,’ ‘psychological stress,’ ‘working memory,’ and ‘young adults.’ The Boolean operator AND was used to combine these terms.

Mental health:

Mental health can be defined as a state of mental well-being (World Health Organization, 2024a) and the absence of psychopathologies such as depression, anxiety, etc. (Westerhof and Keyes, 2010; Singh et al., 2023; Kaur et al., 2023; Lakshmi et al., 2024). Mental well-being helps combat psychological stress and enables individuals to perform well in all aspects of life (World Health Organization, 2024a). It is essential for overall well-being, encompassing emotional, social, and psychological dimensions (Westerhof and Keyes, 2010). Mental well-being is also associated with a reduced mortality rate in both healthy and diseased individuals (Chida and Steptoe, 2008).

Several factors act as protective factors for mental health. Employment, physical activity, and diet are identified as key protective factors (Heinsch et al., 2022). Poor mental health has numerous adverse effects, including poor academic performance, violence, and poor reproductive health (Patel et al., 2007). The disruption of psychological processes may lead to mental disorders (Kinderman, 2005). Mental illness can alter an individual’s thinking, behavior, or feelings (National Institutes of Health (US) & Biological Sciences Curriculum Study, 2007). Psychological stress, also known as mental illness, can impair cognitive functions, such as working memory, in individuals (Qin et al., 2009).

Working memory:

Working memory can be defined as a small amount of information that is readily accessible and can be used to perform cognitive tasks (Cowan, 2014). It plays a vital role in learning, cognitive development, idea complexity, processing speed, and more (Cowan, 2014). Furthermore, working memory is crucial for logical reasoning, problem-solving, decision-making, and information processing (Cowan, 2014; Sankalaite et al., 2023). Different brain cortex regions are involved in working memory, including the prefrontal, cingulate, and parietal cortices (Chai et al., 2018). Some subcortical regions, such as the midbrain and cerebellum, are also engaged in the working memory process (Chai et al., 2018).

Several factors can influence working memory, such as genetics, mental illness, psychological stress, hormones, sleep, and exercise (Blasiman and Was, 2018; Chai et al., 2018). Psychological stress is one of the most significant factors among them. Acute stress can impair working memory processing (Luethi et al., 2009), negatively affecting information processing (Luethi et al., 2009). Moreover, glucocorticoid administration, used as a treatment for stress, has been shown to impair working memory (Luethi et al., 2009). Working memory positively correlates with academic performance (Hussain et al., 2023). Therefore, it is crucial for all types of students.

Relationship between psychological stress and working memory:

Acute stress can modulate working memory through the action of glucocorticoid and mineralocorticoid receptors located in the prefrontal cortex, amygdala, and hippocampus (Oei et al., 2006; Roozendaal et al., 2009). Everyday stressors may decrease working memory (Sliwinski et al., 2006). Authors from different countries have reported the effect of psychological stress on working memory, but with inconsistent findings (Table 1).

Table 1. Studies on the effect of psychological stress on working memory of young adults.

Author	Age of Participants (Mean ± Standard Deviation)	Location of the Study	Effect of Psychological Stress on Working Memory
Oei et al., 2006	21.86 ± 3.89 years	Amsterdam	Impair under high load
Lupien and Hauger1999	23.3 ± 3.5 years	San Diego	Acute stress affects working memory but not declarative memory
Luettgau et al., 2018	26.62±5.16	Leipzig	Acute stress negatively affects working memory
Lukasik et al., 2019	18-65 years	America	No relationship between acute stress and working memory
Sliwinski et al., 2006	80.23± 6.30 (older adults) 20.21 ± 1.09 (young adults)	Syracuse	No effect of stress on working memory

Domes et al., 2001	47.3±10.3 years	Germany	No relationship between stress and non-declarative memory Positive correlation between stress and declarative memory
Singh and Teotia, 2020	18-25 years	National Capital region, India	There is a relationship between anxiety and working memory

To test whether psychological stress could impair working memory, a study was conducted on 20 young, healthy first-year psychology students from the University of Amsterdam (having a body mass index between 19–25 kg/m², with no medical or psychological history). It was reported that psychosocial stress may result in poor working memory performance under high loads but not under low loads (Oei et al., 2006). Lupien and Hauger (2009) conducted a study on 40 young men from the University of California to investigate the effect of psychological stress on a working memory task, a declarative memory task, and a continuous performance task (Lupien et al., 1999). It was found in that study that stress had an acute effect on working memory but did not significantly affect declarative memory.

Another study was conducted on 34 healthy individuals at the Max Planck Institute for Human Cognitive and Brain Sciences to determine the effects of intra-individual stress on working memory (Luettgau et al., 2018). It was found that past subjective stress negatively affected working memory. However, there was no difference in the performance of intra-individual working memory due to acute stress or related stress reactivity (Luettgau et al., 2018). Psychological stress has also been shown to affect forgetfulness (Sandi, 2007). In a study conducted on college students in Egypt, it was found that students with high levels of psychological stress scored significantly lower than their peers with lower levels of psychological stress (Abo Hamza and Helal, 2021).

Interestingly, contrary to previous studies, some reports mention no relationship between psychological stress and working memory. In a study carried out on 503 American adult participants, aged between 18–65 years, it was found that working memory had a negative relationship with anxiety. However, no relationship was found between working memory and stress (Lukasik et al., 2019). Similar results were reported by Domes et al. (2001), who found no effect of stress on non-declarative memory performance. Moreover, stress-induced cortisol levels positively correlated with declarative memory (Domes et al., 2002). Another study conducted on 108 older adults and 68 young adults from Syracuse also found no effect of stress on working memory (Sliwinski et al., 2006).

In India, reports on the effect of psychological stress on working memory are very limited. A study was conducted on 140 young adults aged 18–25 in the National Capital Region of India (Singh and Teotia, 2020). In that study, a significant relationship was found between anxiety and working memory, though it was not specified whether the correlation was positive or

negative. More studies are required from India to establish the effect of psychological stress on the working memory of young adults.

Conclusion:

From the above literature, it is evident that psychological stress definitely impacts working memory. In some cases, psychological stress negatively affects working memory, while in others, there is no significant effect. Since working memory is influenced by acute and temporary factors such as emotional conditions and brain stimulation, there is potential for modification of an individual's emotional state (Blasiman and Was, 2018). The emotional condition of a psychologically stressed individual can be improved through stress management intervention programs. It has been shown that stress management interventions can enhance the working memory of college students (Klein and Boals, 2001).

In addition to psychological stress management programs, mental health policies—such as endorsing mental health goals, promoting well-being, and preventing and treating mental disorders—can be formulated to support mental health. These policies will assist mentally ill individuals in achieving healthy social and psychological functioning. Regularly planning psychological stress management intervention programs and mental health policies is essential to reduce the burden of psychological stress on young adults, representing any country's future. As mental health is a key pillar of sustainable development goals, significant emphasis should be placed on the mental well-being of individuals. Ultimately, this will contribute to an improved socio-economic condition in any nation.

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