The Effects of Hypertension on Cognitive Decline

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August 23rd, 2025

Abstract

Hypertension, or high blood pressure, is one of the most common health conditions for adults today. Its effects, which were once thought to just affect the cardiovascular system, are now seen affecting the mind and cognition. Studies show that midlife hypertension has a significant impact on cognitive function, like memory, attention, and higher-order thinking, when compared to late-life hypertension. The causation of such damage can be traced back to cardiovascular strain, which damages the brain via diseases and overall cognitive impairment. This literature review explores how hypertension impacts cognitive function, examining multiple causal factors linked to cardiovascular strain, followed by prevention and treatment methods aimed at protecting the brain. Overall, understanding the connection between hypertension and cognitive decline can allow healthcare professionals and individuals to make early interventions and improve the health of millions of individuals.

Introduction

Hypertension is one of the most common health conditions affecting adults. Blood pressure is a result of 2 forces: the force of blood pumping out of the heart and into the arteries, and the force of the heart resting between its beats. Hypertension is when the pressure of the blood stays too high for an extended period of time. Chronic hypertension refers to when someone's blood pressure is consistently above 130/80 mmHg. Hypertension is a well-known risk factor for cardiovascular diseases like heart disease, strokes, and more. When blood pressure stays too high, it damages blood vessels and reduces the efficiency with which the heart works.

Hypertension plays a role in brain health and can affect cognitive decline at older ages. Individuals with hypertension, especially in midlife, are more susceptible to problems with memory, thinking, and decision-making abilities. Understanding this connection between hypertension and cognitive decline is crucial, as controlling hypertension not only benefits the cardiovascular system but also brain health.

Hypertension affects the brain mainly through cardiovascular strain. Constantly elevated blood pressure puts stress on the blood vessels, causing them to weaken. This can also reduce blood flow and cause inflammation. This damages neurons, makes the blood-brain barrier less effective, and limits oxygen and nutrients from reaching the brain. Over time, the constant strain can shrink brain tissue and worsen cognitive abilities.

Since hypertension affects both the heart and the brain, it is crucial to understand their link and the root cause. Research in this area helps doctors lessen and slow down the effects of cognitive decline and prevent complications like dementia from occurring. Therefore, this literature review explores how hypertension impacts cognitive function through the lens of cardiovascular strain as well as basic prevention and treatment methods.

Historical Development in the study of hypertension

Hypertension has not always been seen as a condition that affects the brain. The main focus of research on hypertension was its effects on the heart. Research mainly focused on the damage to the heart, blood vessels, and how to prevent cardiovascular diseases. Over time, researchers began to notice the effects of hypertension on cognition. They noticed that people with hypertension in their midlife were experiencing signs of cognitive impairment. This raised questions about the link between hypertension and cognitive function. As more evidence came in, hypertension was not just seen as cardiovascular-related but also as something that could contribute to cognitive decline. This allowed further research to expand on the studies on hypertension, and allowed the link between hypertension and cognitive decline through the pre-existing research regarding cardiovascular strain to be discovered and to grow stronger.

Methodology

To gather relevant sources for the literature review, databases like PubMed, PMC, JAMA Network, and the American Heart Association were analyzed. Keywords that were used to search included “hypertension”, “cognitive decline”, “high blood pressure”, and “cardiovascular strain.”

Studies were included if they looked at the relationship between hypertension and cognitive function, as well as exploring cardiovascular mechanisms that contributed to cognitive decline. Studies were excluded if they were non-English publications, opinion pieces, or animal studies.

Mechanisms Linking Hypertension and Cognitive Decline

Hypertension contributes to cognitive decline in direct and indirect ways. High blood pressure directly puts stress on the heart and blood vessels, limiting oxygen and nutrients to the brain. This damages small vessels, causing microinfarcts, white matter changes, leading to brain atrophy and impairment in memory, attention, and executive functioning (Canavan & O'Donnell, 2022). Hypertension also weakens the blood-brain barrier, which indirectly is the cause of toxic molecules being able to enter the brain, linking hypertension to diseases like Alzheimer's. Fluctuations in blood pressure add additional stress to the blood vessels and worsen the vascular damage, and midlife hypertension can only amplify the damage to the brain. Altogether, hypertension leads to vascular damage, which then damages the brain, causing cognitive decline.

Cross-sectional studies, which look at groups of people at once, give us more evidence linking hypertension and cognitive abilities together. In one study, adults with hypertension performed significantly worse at higher-level thinking skills like planning, memory, and shifting between tasks (Moraes et al., 2020) compared to those who did not have hypertension. This study also showed us that individuals who controlled their blood pressure performed much better in these tests than those who did not. This highlights the importance of managing blood pressure and the effects of managing it day to day, as it can lead to some retention in cognitive abilities, which would not have been there if their hypertension were not controlled. This clearly depicts the direct link that hypertension has on cognition, underpinned by cardiovascular strain, which is what these effects point towards. Keeping blood pressure in check can improve brain health and cognitive function.

Factors Modifying the Impact of Hypertension on Cognition

Timing of Hypertension

The timing of hypertension can be one of the biggest indicators and predictors of cognitive decline for people later in life. Research shows that hypertension in midlife, between 45 and 65, has a larger impact on brain health than when compared to hypertension that develops after that age range. A Honolulu-Asia Aging study found that individuals with hypertension in midlife were more likely to experience a decline in memory, attention, and overall cognitive function (Launer et al., 1995). This suggests that prolonged exposure to high blood pressure can gradually damage the brain. It can do so even before any symptoms appear, as the strain on the blood vessels and neurons builds over time.

A 20-year cohort study on midlife hypertension studied individuals for two decades and found that those individuals with hypertension who were left untreated experienced a greater decline in cognitive abilities, such as memory, processing speed, and higher-order thinking. Individuals who were treated for hypertension did not see these effects (Gottesman et al., 2014). Even smaller increases in blood pressure, like prehypertension, saw some cognitive decline, although it was not as severe as with individuals who did not treat their hypertension. The need to control blood pressure before it reaches very high levels is crucial, as hypertension continually strains the blood vessels and reduces blood flow to the brain.

Age at Diagnosis

The age at which someone gets diagnosed with hypertension also affects the degree to which cognitive function is impaired. The CHARLS study saw that individuals who were diagnosed with hypertension before the age of 55 experienced drastic and faster declines in

memory, orientation, and overall thinking skills compared to those individuals who were diagnosed later in their life or even individuals who were never diagnosed with hypertension in the first place (Ding et al., 2022). This occurs as early exposure to cardiovascular strain and strain placed on the brain can negatively affect the blood vessels, neurons, and reduce oxygen and nutrient flow. This is different when compared to hypertension, which is diagnosed later in someone's life as their brain has developed more and is not under strain for the duration that early hypertension individuals are.

Blood Pressure Variability

It is not just hypertension itself that contributes to cognitive decline - how much the blood pressure changes also affects cognitive function just as much. A pooled analysis from three national cohorts found that individuals whose blood pressure changed from visit to visit experienced a faster decline in memory and thinking ability. The surprising fact was that all these side effects happened even though their overall blood pressure was reasonably controlled with medication (Zheng et al., 2024). The variability in the blood pressure puts extra stress on the blood vessels both in the brain and in the heart, leading to small injuries, inflammation, and reduced oxygen supply to the brain. Even if someone maintains their blood pressure with medications, the fluctuations in blood pressure can still cause cognitive problems. Stability in the blood pressure is just as important as controlling how high it is. This study shows us that both the stability and level of blood pressure matter for protecting brain health.

Gender Differences

Hypertension can affect men and women differently when it comes to thinking and memory. A cross-sectional study with adults ranging from 45 to 55 years old found that hypertension in midlife was overall linked with memory and attention issues. However, this study uncovered that men struggled mostly with attention, while women, on the other hand, struggled with not only attention but also memory (Shields et al., 2023). This could be due to the differences in blood vessels in men and women, and how the brains respond to the long-term cardiovascular strain caused by hypertension. Understanding these differences is very important as treatments might differ based on gender. For example, women with midlife hypertension might need more support for memory and processing skills, compared to men who might need more support with attention-related things.

Late-Life Hypertension

Hypertension in late life is not as damaging as midlife hypertension, according to research. In one study, older adults with and without hypertension performed memory and thinking tests, with them performing almost the same. After about seven years of follow-up, the people with hypertension did significantly worse on tests like letter fluency and digit ordering (Moll & Woodard, 2022). This pattern shows that late-life hypertension might not be as dangerous as midlife hypertension. This only proves that midlife is a period where individuals must control and maintain their blood pressure. It is also the time when uncontrolled hypertension does the most damage. This isn't the case for individuals who get hypertension later, as the age factor takes over. A limitation in this study was that the differences were also small enough to be explained by other health problems like diabetes, high cholesterol than just

blood pressure. However, this study reinforces the fact that midlife is a very important time for not just brain health but overall health.

Prevention and Intervention

Early Detection

Early detection and management of hypertension are crucial for protecting both brain and cardiovascular health. Midlife hypertension in particular is strongly linked to cognitive decline, including problems with memory loss, slower thinking, or even dementia (Suvvari, 2023). Identifying and addressing hypertension early can prevent years of vascular strain that could have directly led to decreased cognitive abilities.

Lifestyle Changes

Lifestyle interventions such as regular exercise, a healthy diet, and stress-reducing habits can all help lower blood pressure and improve vascular health. Exercise helps build cardiovascular health, and the improved vascular health and lowered blood pressure directly translate into better brain health, as there is more oxygen and nutrients entering the brain. There is also less white matter damage as a result of the decreased vascular strain. The prevention of vascular strain, in turn, helps reduce the effect of cognitive decline, such as loss of executive function and attention (Cheon, 2022).

Medical Intervention

When lifestyle changes are not enough, the introduction of medication is important as it can play a large role in reducing the effects of hypertension on the body. Medications reduce

vascular stress and stabilize blood pressure, preventing the body from being in cardiovascular strain for extended periods of time. This, in turn, lowers the risk of damage to blood vessels and the brain. By protecting vascular health, medications can help reduce the effects of cognitive decline and also prevent diseases like dementia or Alzheimer's.

Analysis

The findings of the review highlight the connection between hypertension and cognitive decline. Hypertension limits blood flow and oxygen to the brain, leading individuals to experience memory loss, slower thinking, and even dementia. Evidence from human studies shows us that midlife hypertension is particularly harmful, but early detection and treatment can help lower the risk of cognitive decline.

A strength of the studies used is that they approach the topic from different angles, together creating a better overall picture. Large cohort studies and meta-analyses provide large amounts of data linking hypertension with cognitive decline. Certain studies also included diverse populations, increasing the generalizability of the findings. Focusing on specific mechanisms like blood pressure variability and executive function allows for a more precise understanding of how hypertension affects cognitive functions over time.

A weakness of the studies used is that the sample sizes for a majority of the studies were relatively small or were specific age ranges. This could affect the generalizability of the findings. Another weakness was that confounding variables such as diabetes, cholesterol, and lifestyle also could have made the findings less general. Overall, the studies relied on cognitive tests instead of actual imaging so it limits the ability to link hypertension with structural changes.

Conclusion

Hypertension contributes to cognitive decline primarily through cardiovascular strain. The elevated blood pressure for an extended period of time damages blood vessels, reduces blood flow, limits oxygen and nutrients to the brain, and weakens the blood-brain barrier. All this can lead to brain atrophy and decline in cognitive abilities such as higher-order thinking, memory, and attention, particularly when hypertension occurs in midlife of an individual. Multiple studies suggest that controlling hypertension through early detection, lifestyle changes, and medication has the potential to reduce cognitive decline. This literature review highlights the need for protecting both cardiovascular and brain health by controlling hypertension. Managing hypertension is not only important in preventing vascular issues, but also in maintaining cognitive functions and overall well-being.

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