RESEARCH ARTICLE

The Role of Systemic Chronic Inflammation and Shared Neuroinflammatory Loops in Neurodegeneration: A Literature Review

Suriyaa Sabaribala
Athens High School, 4333 John R Road, Troy, MI 48085 , USA; suriyaaxmen@gmail.com

Abstract

This study analyzed the role of chronic inflammation in neurodegeneration with special consideration for external variables like alcohol intake, gut inflammation, and the immune system. The goal was to examine the impact of systemic inflammation on neurodegeneration and its contribution to cognitive disorders, neuronal damage, and Alzheimer's and Parkinson's diseases. The literature analysis method was applied to study scientific articles published in academic databases such as PubMed. The outcomes revealed that inflammation is an important factor in causing and accelerating neurodegeneration due to its development in external locations like the gut and immune system and subsequent spread to the brain via blood-brain barrier damage, microglia activation, cytokines, and reactive oxygen species. Lifestyle aspects like alcohol abuse and excessive high-fat diet were associated with the exacerbation of inflammation, oxidative stress, and neuronal damage manifested in protein changes such as tau tangles and amyloid plaques. A cycle of inflammation and neuronal damage was identified, although specific links and interactions between risk factors require further exploration. Future research should examine the cumulative impact of alcohol consumption, dietary habits, and gut microbial dysbiosis. More human-based clinical studies are needed, and potential treatments, including anti-inflammatory drugs, antioxidants, and neuroprotectants like melatonin, should be explored further.

Keywords

Cellular and molecular biology; neurobiology; neuroinflammation; neurodegeneration; gut-brain axis; blood-brain barrier; inflammation; Cellular Immunology; cognitive decline

Introduction

In neurodegenerative diseases, the brain and the nervous system experience slow damage over time. As time progresses, individuals frequently experience significant memory impairment and performing physical movements becomes difficult and the capacity for clear thought is lost. Scientists believed that proteins which fold in an incorrect manner cause these diseases.[1] It was also commonly believed that genes played the primary role, but current research demonstrates that chronic inflammation is a significant factor.[2] Among the factors that cause neurodegenerative diseases, approximately 10% of cases are inherited genetically. Although the percentages for many other causes of neurodegeneration are unknown, research indicates that two-thirds of individuals with neurodegenerative diseases had elevated neuroinflammation levels. A multitude of factors contribute to neurodegenerative diseases like environmental factors such as smoking, alcohol consumption, prolonged exposure to pesticides, mutations in the genome, aging, and inherited predisposition. [1]

Inflammation is the body's natural response to infection. When inflammation becomes chronic, it begins to destroy healthy cells. For example, prolonged inflammation can cause harm to brain cells. Microglia and astrocytes are present in the brain during inflammation. The gut and the brain are very closely linked by a system that scientists refer to as the gut-brain axis. Disruptions in the gut biome in the digestive system can lead to chronic inflammation throughout the body.[3] Alcohol weakens the gut lining, allowing damaging substances, particularly lipopolysaccharide, to enter the bloodstream. This increases inflammation and may also harm the blood-brain barrier, the protective covering of the brain. When that brain barrier is damaged, it becomes easier for inflammatory substances to get into the brain and create neuroinflammation. Research indicates that diet plays a very important role. The kind of high-fat, high-sugar diet typical in western diets can cause a mild but consistent level of inflammation, damage the blood-brain barrier, and encourage the formation of amyloid plaques.[4] Along the same lines, high-fat diets increase indicators of inflammation and activate immune cells within the brain.[5]

Currently, alcohol, disorders in the digestive system, and damage to tau are examined in many studies as separate entities, not how they influence each other. Researchers do not yet have a complete picture of what occurs when inflammation in the gastrointestinal tract affects the blood-brain barrier, subsequently triggers inflammation in the brain, and eventually causes brain cells to die. Some treatments appear promising but require further investigation. In fact, we still need to better understand how long-term inflammation contributes to neurodegeneration. This paper explores alcohol's effect on the gut-brain axis, alterations in the blood-brain barrier, and how microglial cells become activated leading to neuroinflammation arising in the hippocampus, cortex, and other brain regions. It also examines damage to neurons, alterations in tau, and amyloid plaques, all in relation to inflammation, however, many questions remain unanswered.

Understanding of the mechanisms of inflammation in the development of neurodegenerative disease is critically important. This research could show how lifestyle factors such as alcohol and high fatty diet, increase the risk of neurodegenerative diseases, help identify early warning signs of cognitive decline, discover new treatments that focus on reducing inflammation, and encourage healthier lifestyle choices to protect brain health. While there are many other factors that contribute to neuroinflammation causing neurodegenerative diseases, this paper primarily focuses on alcohol and western diets since they directly influence gut health. Pesticides and other factors are excluded from this research paper since they do not disrupt the gut biome and the gut-brain axis directly.

Methods

In this study, the articles used for research include both studies conducted on humans and animals, as well as molecular/cellular experiments. Examining various types of literature will enable researchers to get a clearer picture of the role played by inflammation in promoting neurodegeneration. The literature cited in this paper is taken from peer reviewed scientific journals and academic databases. The review focuses on studies published from 2014 to 2026 to ensure the inclusion of current and relevant research on the topic. Main sources of data include databases such as PubMed and journals including Frontiers in Immunology, Neurobiology of Disease, and Nature.com.

To obtain useful sources for this research, a number of key terms were used. These include keywords such as "neuroinflammation", "neurodegeneration", "gut-brain axis", "blood-brain barrier", "inflammation", "oxidative stress", "cognitive decline", and "alcohol induced neuroinflammation". Only articles written in English that provided a clear explanation of the impact of inflammation on neurodegeneration were considered appropriate. Studies were excluded if they focused primarily on acute traumatic brain injury, non-neurological inflammatory conditions, or non-English publications. Those which explored issues related

to diet, gut microbiota, immune response, and cell signaling processes were most relevant to this work. A total of 92 sources were initially acquired, and 14 studies were found suitable for this research. Once all the sources were acquired, the data obtained were compared.

Within the framework of the study, no experiments involving participants or any testing on humans or animals were carried out, since all the information was gathered from previous publications and resources containing scientific data. Therefore, this study did not require any ethical approval, as all information is obtained through the analysis of the previous works.

Results

The researchers' findings support the idea that inflammation beginning in the body, rather than within the brain itself, can significantly alter brain functions.

There is evidence linking environmental factors to brain decline due to inflammation. Alcohol activates immune cells in the brain, called microglia.[6] Once activated, these microglia release inflammatory cytokines such as TNF-α, IL-1β, and IL-6. These substances serve an important role in protecting the body, but excessive levels can injure brain cells. Prolonged alcohol consumption causes oxidative stress, issues with mitochondria, and ultimately cell death. Alcohol impacts neural stem cells in the hippocampus (the brain's memory center). Damage to these cells affects the brain's ability to produce new neurons, causing both loss of memory and a worsening of cognitive skills. This persistent inflammation may raise the risk of developing neurodegenerative diseases over time.

Inflammation is also associated with tau, a protein that causes Alzheimer's disease. Tau develops into tau tangles in neurons, a process which is abnormal, and can destroy brain cells. Inflammation can in fact intensify tau-related damage.[7] Their experiments on animals showed that lowering tau levels safeguarded neurons from damage caused by inflammation. This suggests that inflammation might begin prior and make tau abnormalities more severe, rather than being a result of them. And because of inflammation's significant impact, scientists are now investigating therapies to reduce it.[8] For example, have been studying melatonin. Melatonin is a hormone your body produces naturally and is a regulator of sleep. Since melatonin can cross the blood-brain barrier, it may be useful in protecting brain cells from inflammation-related damage. Lots of research has linked inflammation to neurodegenerative diseases, but there is still much to learn.

This study explored how chronic inflammation contributes to neurodegenerative diseases, especially in relation to alcohol consumption, gut health, and brain function for this research. By analyzing multiple scientific studies, clear patterns were identified showing that chronic inflammation plays a central role in damaging neurons and affecting brain health. The results also show that inflammation does not act alone but instead works through interconnected systems such as the gut-brain axis and immune responses.

Microglial Activation and Chronic Neurodegenerative Cascades

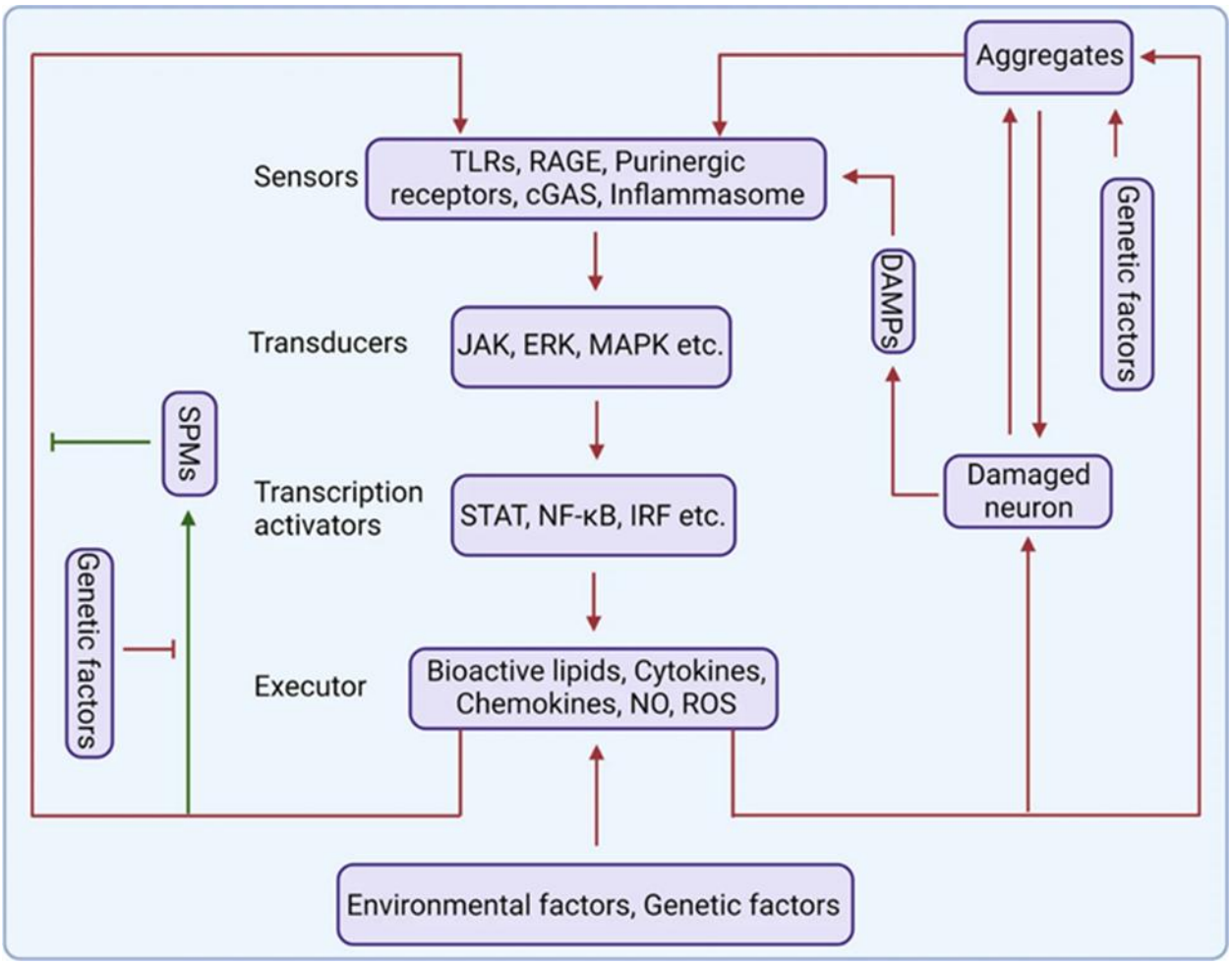

Figure 1: Signaling Pathways & Inflammation Loop. This figure illustrates the self-perpetuating cycle of chronic neuroinflammation, a process believed to contribute to neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and ALS. Source: https://rdcu.be/fpm8A https://doi.org/10.1038/s41392-023-01486-5 Paper Title: Role of neuroinflammation in neurodegeneration development

Figure 1 [9] illustrates a linear cascade of neuroinflammatory events that starts from environmental and genetic stimuli and proceeds via immune signaling until the development of neuronal injury, while also illustrating how the process may be exacerbated or alleviated. Environmental factors (toxins, trauma, infection) and genetic factors initiate neuroinflammation by promoting the formation of protein aggregates and stimulating immune signaling. Protein aggregates, together with Damage Associated Molecular patterns (DAMPs) produced by damaged neurons, cause neuronal injury. DAMPs act as danger signals that activate cellular sensors, including Toll-like receptors (TLRs), receptors for advanced glycation end products (RAGE), purinergic receptors, cytosolic DNA sensors (cGAS), and inflammasome. After activation, these sensors initiate intracellular signaling mediated by transducers, including Janus kinase (JAK), extracellular signal-regulated kinase (ERK), and mitogen-activated protein kinase (MAPK). Transducer-mediated signaling is furthered by the induction of downstream effectors: nuclear factors STAT, nuclear factor kappa-light-chain-enhancer of activated B cell (NF-κB), interferon regulatory factor (IRF), which are transferred into the nucleus to activate pro-inflammatory molecules to restart the cycle. The red arrows in the picture highlight pro-inflammatory and damaging mechanisms. The red arrows illustrate how

aggregates and DAMPs activate sensor cells, how signaling is propagated down from the top to the bottom, starting from transducers, then transcription factors, and finally inflammatory mediators, and how inflammatory mediators signal back to aggravate neuronal damage. Therefore, it forms a self-reinforcing loop in which neuronal damage leads to the release of more DAMPs, activating sensors and causing chronic inflammation. Additionally, red arrows illustrate genetic enhancement of the damaging process, such as increased aggregate accumulation or a stronger inflammatory signaling cascade. Conversely, green arrows illustrate beneficial pathways where SPMs mediate inhibition of inflammation by interrupting parts of the signaling cascade and reducing secretion of executioner molecules, leading to the promotion of resolution and repair. However, genetic inhibitors can act against these beneficial mechanisms, as seen by the red line intersecting the green pathway. This figure ties into this research because the findings show that alcohol can cause the neurodegeneration process to happen even after the individual quits drinking. This is because it's a self reinforcing cycle and the window to stop neurodegeneration is small.

Neuroinflammatory Feedback Loops in Alzheimer's Disease

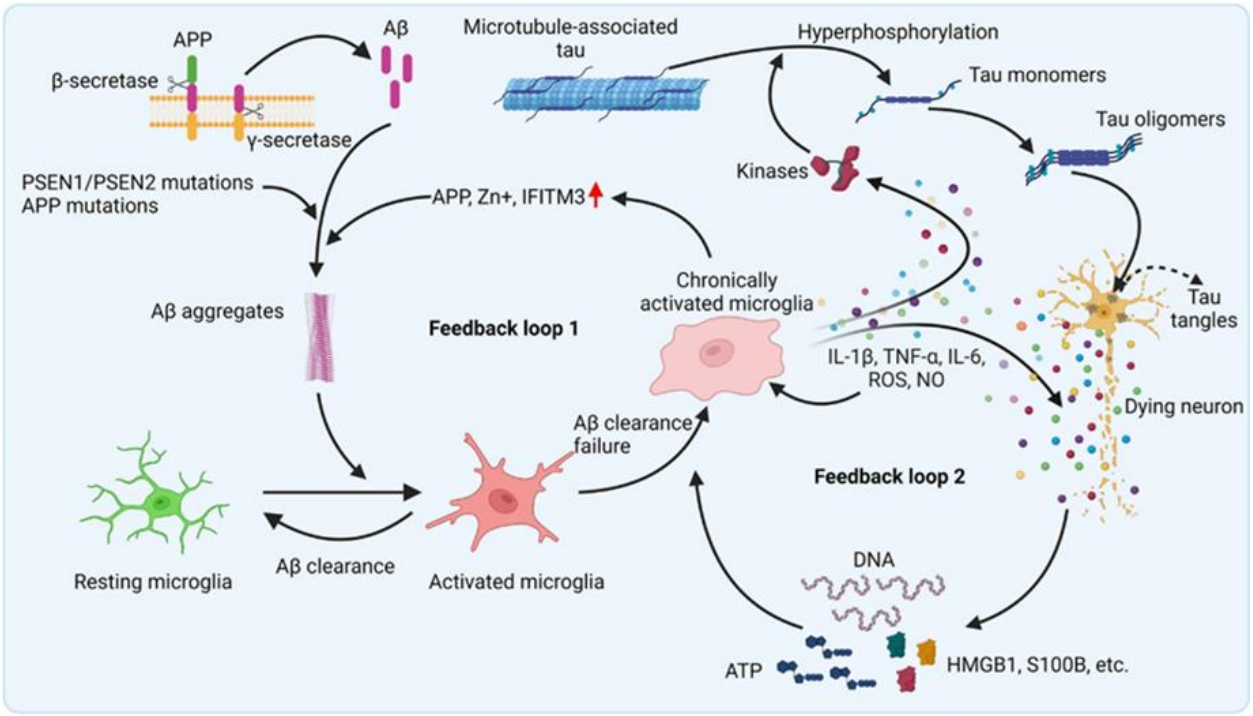

Figure 2: How Chronic Inflammation Connects to Alzheimer's. Inflammatory mediators promote further neuronal injury, impair Aβ clearance, and accelerate tau pathology, creating self-perpetuating cycles that contribute to progressive neurodegeneration. Source: https://rdcu.be/fpm8A https://doi.org/10.1038/s41392-023-01486-5 Paper Title: Role of neuroinflammation in neurodegeneration development

Figure 2 [9] begins with APP (Amyloid Precursor Protein) embedded in the neuronal membrane, which is sequentially cut by β-secretase and then γ-secretase to release Aβ peptide fragments. This cleavage process is significantly worsened by mutations in PSEN1, PSEN2, and APP, which causes overproduction of misfolded, aggregating Aβ peptides.

The Aβ peptides misfold and aggregate into Aβ aggregates, also known as amyloid plaques, which are detected by the brain's immune cells known as resting microglia. They convert into activated microglia that attempt to remove the Aβ aggregates, however, when there are too many aggregates for the microglia to remove, this results in Aβ clearance failure, which subsequently leads into Feedback Loop 1. In this loop, increased Aβ upregulates APP cleavage, Zn^{2+} ions, and IFITM3 (the red upward arrow), which increases γ-secretase activity, causing more production of Aβ peptides in an endless loop.

Alongside this process, microtubule-associated normal tau proteins, responsible for stabilizing the neuronal skeleton, become hyperphosphorylated by abnormal kinases such as GSK-3β and CDK5, resulting in the release of the tau proteins from microtubules and their misfolding, followed by aggregation of small toxic tau oligomers that develop within the cells.

These tau tangles, when paired with the harmful effects of Aβ, lead to neurodegeneration, causing dying neurons to burst open and release intracellular DAMPs such as DNA fragments, ATP, and alarmins HMGB1 and S100B, which microglia detect as potent danger signals. These signals push microglia to become chronically activated, leading to increased secretion of a variety of dangerous substances, including IL-1β, TNF-α, IL-6, ROS, and NO. These molecules are highly inflammatory and directly harmful to neurons, resulting in further neuronal death, and increasing the release of DAMPs, causing even more microglia activation, thereby forming an endless feedback cycle of escalating neurotoxicity and inflammation.

Loop 2 is linked to Loop 1, since chronic activation and secretion of inflammatory mediators prevent Aβ clearance by activated microglia, increasing Aβ accumulation to further impair their function, and reactivating Loop 1, thereby worsening neurodegeneration through increased inflammation and neuronal cell death.

Neuroinflammatory Mechanisms Driving Parkinson's Disease Progression

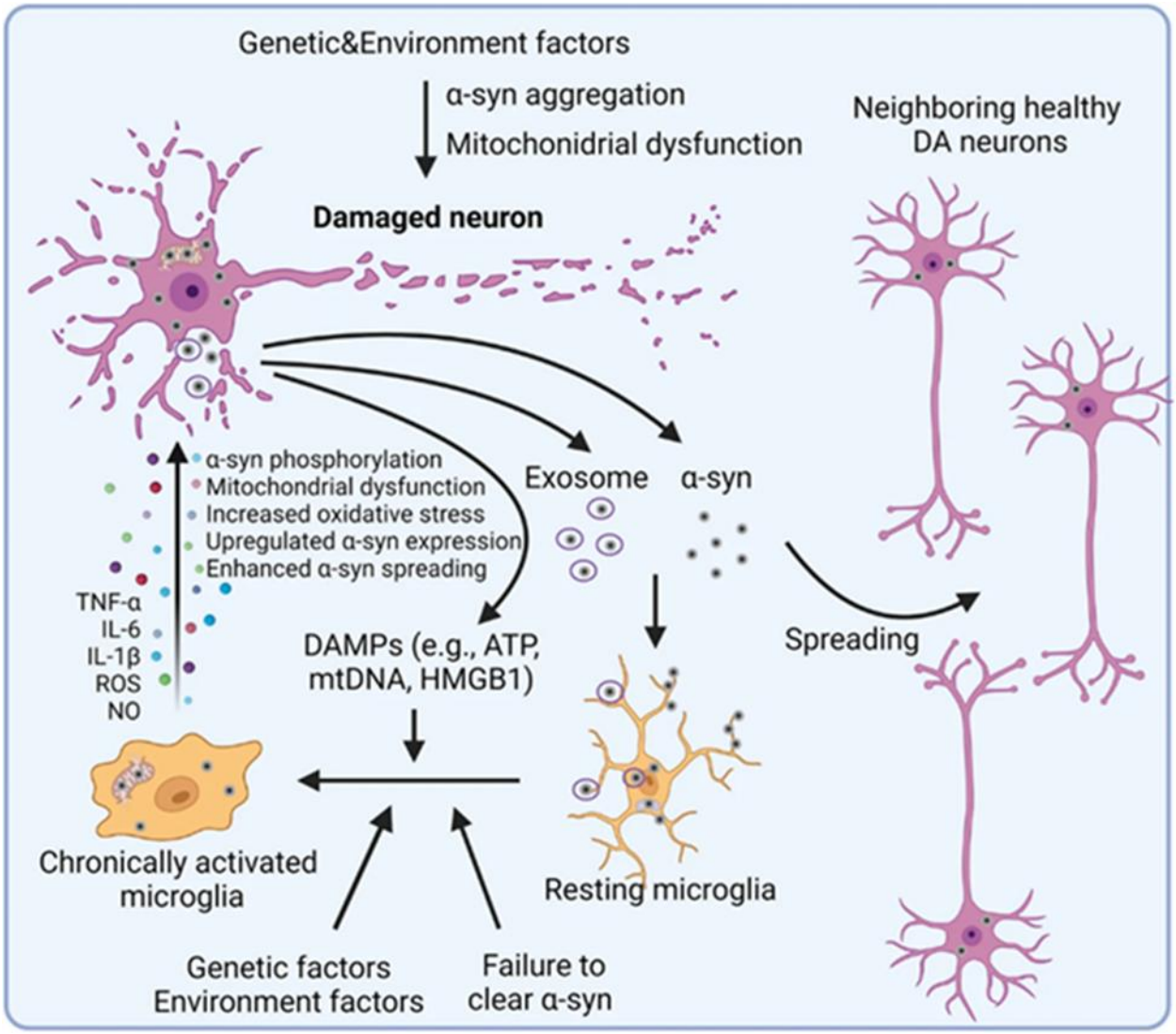

Figure 3: How Chronic Inflammation Connects to Parkinson's. α-synuclein accumulation and chronic microglial activation cause ongoing neuronal damage in Parkinson's disease. Neuroinflammation creates feedback loops that worsen disease progression and promote the spread throughout the brain. Source: https://rdcu.be/fpm8A https://doi.org/10.1038/s41392-023-01486-5

Figure 3 [9] shows the progression of a neurodegenerative disease, specifically Parkinson's disease. As a result of genetic and environmental influences, two processes occur inside a neuron leading to its degeneration: alpha synuclein (α-syn) aggregation and mitochondrial dysfunction.

Within a damaged cell, the chain reaction proceeds with further aggravation of phosphorylation of α-syn, mitochondrial dysfunction, oxidative stress, which causes an increase in α-syn transcription and its propagation. The damaged neuron then starts releasing toxic substances into the extracellular medium in the form of two components: exosomes (vesicles containing toxic cargo) and α-syn, which emits DAMPs such as ATP, mtDNA, and HMGB1, which are signaling molecules that alert the immune system to the presence of a threat.

In turn, the toxic material is taken up by resting microglia cells (immune cells of the brain), while DAMPs and other genetic and environmental factors activate the microglia and worsen their condition due to an inability to properly degrade α-syn proteins. This leads to chronic microglia activation, and the release of pro-inflammatory substances from activated microglia: TNF-α, IL-6, IL-1β, ROS, and NO, which are capable of damaging both neurons and nearby cells. This creates a feedback loop that acts on the damaged neuron and surrounding tissue, amplifying the damage in a self-perpetuating cycle.

Simultaneously, the free α-syn spreads via a prion-like mechanism to neighboring healthy dopaminergic (DA) neurons, progressively infecting them and propagating neurodegeneration throughout the brain.

Microglial Activation and Neuroinflammatory Feedback Loops in ALS

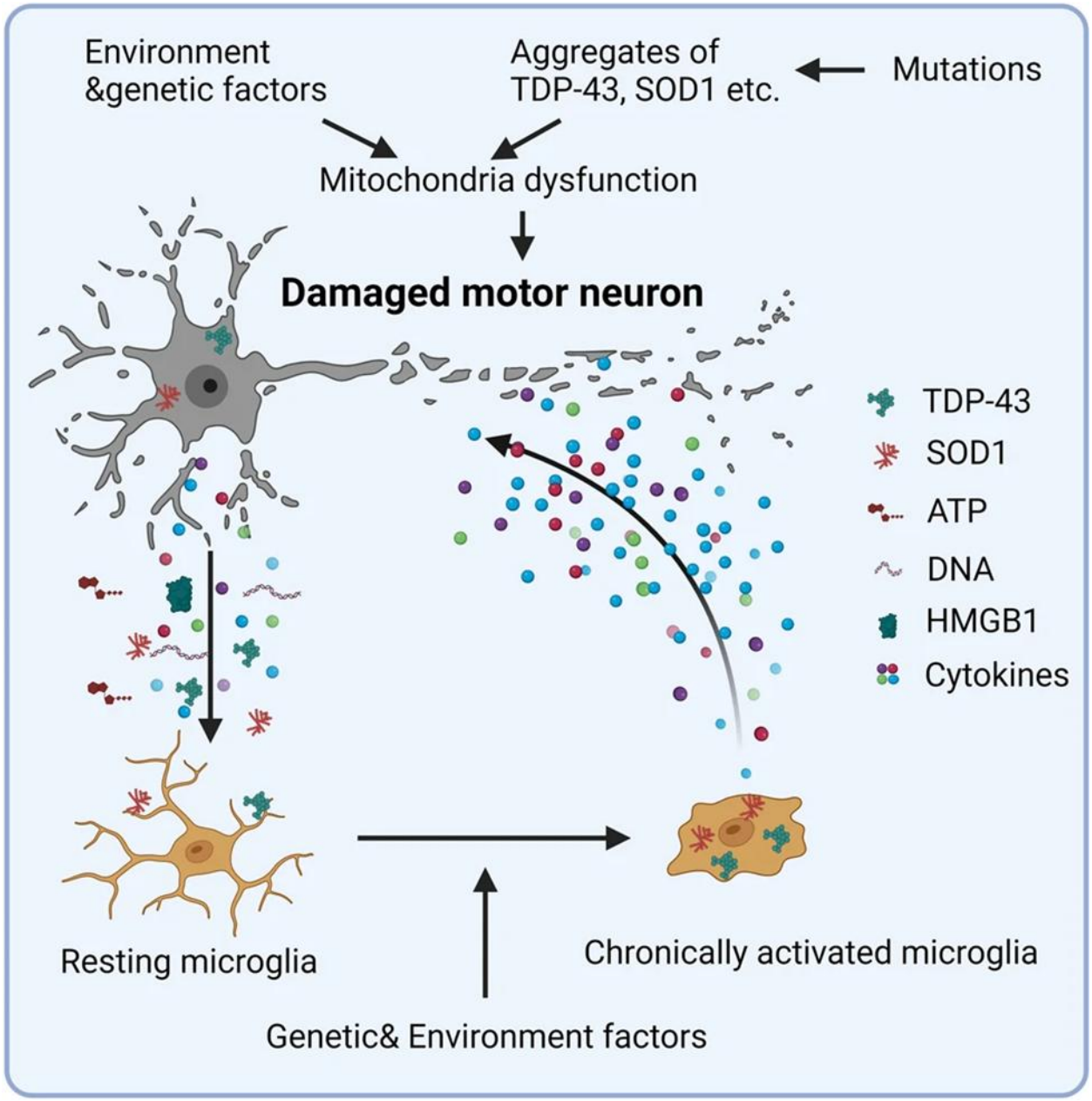

Figure 4: Environmental & Genetic Factors. ALS neuroinflammatory cascade showing protein aggregation, motor neuron damage, microglial activation, and chronic inflammatory feedback. Source: https://rdcu.be/fpm8A https://doi.org/10.1038/s41392-023-01486-5

Figure 4I [9] demonstrates the pathological pathway of neuroinflammation in ALS. First, mutations in genes initiate the production of toxic protein aggregates, such as TDP-43 and SOD1, alongside genetic and environmental risk factors, leading to dysfunction in the mitochondria of motor neurons.

Mitochondrial dysfunction induces motor neuronal damage, which triggers the secretion of danger-associated molecular patterns from the motor neuron into the environment, including ATP, DNA fragments,

HMGB1, cytokines, and misfolded proteins (TDP-43 and SOD1). These danger-associated molecular patterns serve as alarm molecules, activating resting microglia, the resident immune cells of the brain, depicted in their branched form in the left portion of the image.

Activated by the released alarm molecules, along with the influence of other genetic and environmental factors, the resting microglia undergo chronic activation, represented by the cell on the right with its compact morphology. This chronic activation is problematic since the activated microglia secrete inflammatory factors towards the injured motor neuron, as denoted by the curved arrow directed upwards, establishing a feedback loop.

Gut Dysbiosis, Blood-Brain Barrier Disruption, and Neuroinflammatory Cascades in Alzheimer's Disease

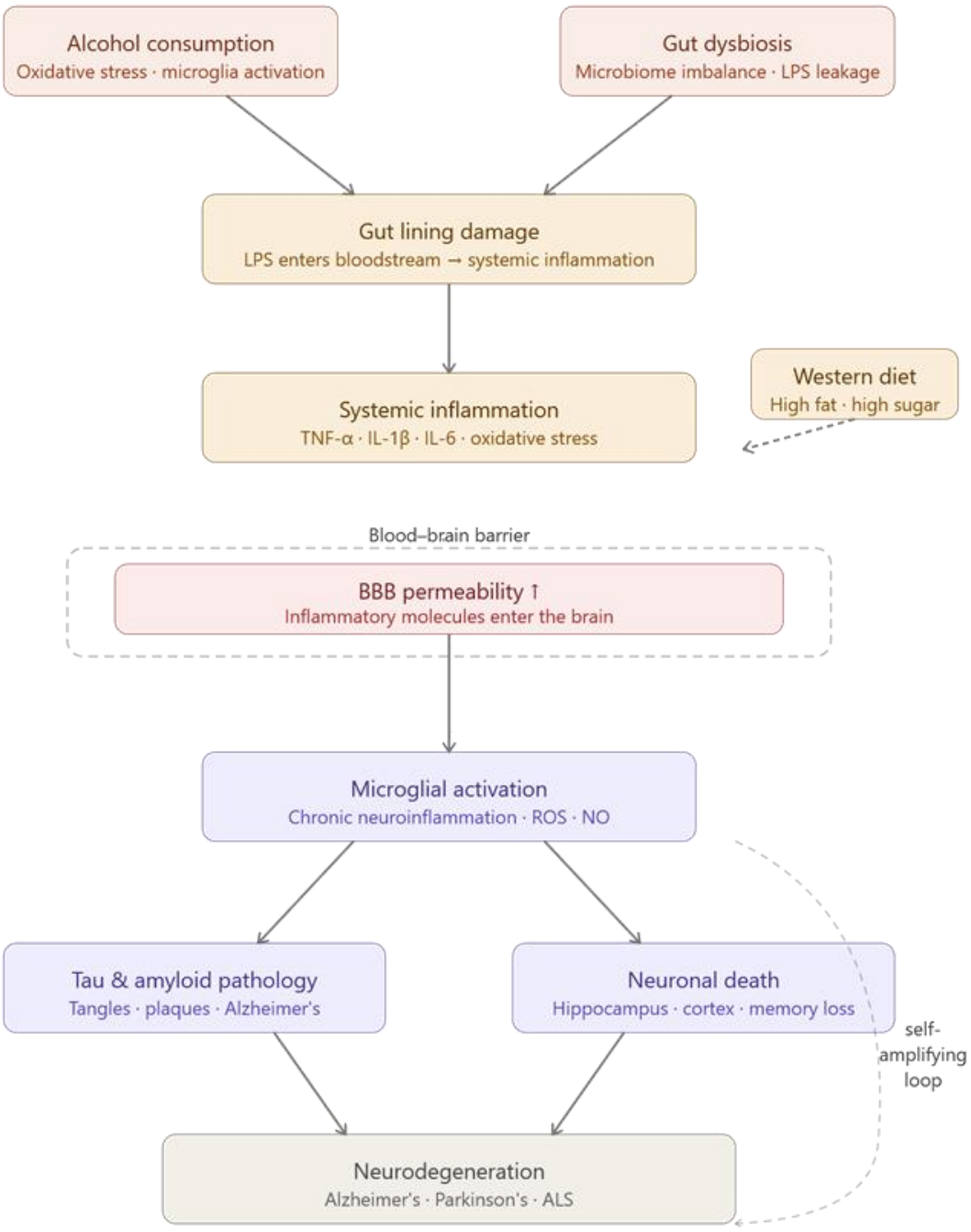

Figure 5: Inflammatory cascade from gut dysfunction to neurodegeneration. Problems in the gut can lead to inflammation in the brain. Damage to the gut lining allows harmful substances to enter the bloodstream, causing brain inflammation that may lead to nerve cell damage and diseases like Alzheimer's and Parkinson's. Source: Created using Claude AI

Figure 5 [9] illustrates how alcohol causes microglial activation and oxidative stress, while gut dysbiosis causes a microbiome imbalance, both of which lead to the weakening of the gut lining causing LPS and other bacterial products to leak into the bloodstream, triggering cytokine to release (TNF-α, IL-1β, IL-6) throughout the body.

This causes systematic inflammation, with a Western diet acting as a secondary driver of systemic inflammation. The systemic inflammation causes the blood-brain barrier to weaken, allowing inflammatory molecules to enter the brain. This causes the immune system to react causing microglia to become chronically activated, releasing ROS and neuroinflammatory mediators in a self-reinforcing feedback loop (shown by the dashed arrow on the right).

Microglial activation causes tau tangles and amyloid plaques (Alzheimer's pathway), while also directly causing hippocampal and cortical neuron death, both converging on end-stage neurodegeneration.

Discussion

One of the research questions of this study: why does neuroinflammation persist and worsen even when the original trigger is removed? The answer is that the inflammatory loop becomes independent of its cause. For example, a person who stops drinking alcohol may have already set a neuroinflammatory cycle in motion that continues long after alcohol exposure ends. This has major implications for early intervention suggesting that the window of opportunity for reversing or stopping neuroinflammation may be narrow, and that waiting for symptoms of neurodegeneration to appear before intervening may already be too late.

The scientific question addressed by this study was whether inflammation causes cognitive dysfunctions and neuronal destruction, and the conclusion is yes. As for the reasons why Alzheimer's patients continue getting worse despite the application of treatments targeting proteins, is because inflammation is what makes the formation of amyloid plaques possible and, in turn, makes it impossible to control the disease progression.

Another of the study's research questions about how inflammation accelerates neurodegeneration. In Parkinson's disease, inflammation does not just kill existing damaged neurons, it enables the expansion of neurodegeneration throughout the brain. This helps explain the progressive nature of Parkinson's symptoms, which worsen steadily over time as more dopaminergic neurons are lost. It also raises an important therapeutic implication: reducing the inflammatory burden may not only protect existing neurons but also potentially slow or block the cell to cell spread of alpha-synuclein, halting disease progression at a cellular level rather than merely managing symptoms.

The importance of Figure 4 for addressing the research question within the scope of the study is that it indicates that neuroinflammation is not just a random factor in all diseases but serves as a common denominator for all three disorders in the pathogenesis process. The same pattern of inflammation exists for both Alzheimer's, Parkinson's, and ALS, then therapeutic strategies targeting shared components of this loop such as NF-κB signaling, chronic microglial activation, and oxidative stress may offer neuroprotection across multiple diseases, rather than needing to be reinvented for each disease separately.

One of the central research questions of this study: how do external variables such as alcohol and diet contribute to neurodegeneration? Scientists originally believed that neurodegenerative diseases such as Parkinson and Alzheimer’s originated due to damaged or misfolded proteins in the brain. However, more recent research revealed that contrary to prior belief, these diseases don't originate in the brain but involve the entire body and more specifically changes in the gut biome. External factors such as alcohol and high fatty diets can initiate the entire neuroinflammatory cascade from the gut upward in individuals who may

appear neurologically healthy. This is significant because it repositions neurodegeneration as a preventable condition. If gut dysbiosis and chronic systemic inflammation are drivers of brain damage, then dietary interventions, alcohol reduction, and gut microbiome management represent legitimate neuroprotective strategies, not just general health advice. It also suggests that clinical monitoring of gut health and systemic inflammatory markers may serve as early warning indicators of neurological risk long before cognitive or motor symptoms emerge.

The practical significance of these combined findings is that neurodegenerative diseases are systemic, rather than a purely neurological disease. Addressing it effectively will likely require interventions at multiple points simultaneously, reducing inflammation through lifestyle and diet, protecting the blood-brain barrier, restoring microglial resolution capacity, and targeting the shared pro-inflammatory signaling pathways that drive neuronal death across these conditions.

Conclusion

This research paper underscores the importance of chronic inflammation as an interconnected process between various lifestyle related conditions and neurodegenerative diseases. These findings show that neurodegenerative diseases such as Parkinson's, Alzheimer's and ALS are influenced by the interaction between the gut-brain axis, blood-brain barrier, microglial activation, oxidative stress, and protein abnormalities. This is important because inflammation may not simply happen after neurodegeneration begins; it may also help start the disease and speed up its progression.

More importantly, this review highlights a major gap in current research. Alcohol consumption, gut dysbiosis, blood-brain barrier disruption, and abnormal protein accumulation are often studied independently instead of being studied as parts of the same biological network. As a result, scientists still lack a complete understanding of how these interconnected factors interact over time to cause neuronal damage. Another important issue related to previous investigations of the phenomenon under discussion is the use of animal studies, which makes the findings less generalizable to humans.

Future research will likely consider several factors simultaneously, such as alcohol consumption, dietary habits, and the gut microbiome. Moreover, there is a need to examine the effectiveness of some interventions to mitigate the inflammatory response, e.g., antioxidant agents or melatonin administration. Additionally, future research involving more clinical trials on humans would be appropriate to confirm these results. Clinical trials need to be conducted to test whether early anti-inflammatory intervention before neurological symptoms appear, can meaningfully reduce the risk and rate of neurodegeneration.

Acknowledgements

I would like to thank Professor Jen for their assistance in writing this paper. I would also like to thank Professor Jobin for providing guidance and ideas for this work, as well as for teaching me the basics of neuroscience, which enabled me to complete this paper. Finally, I would like to thank my parents for their encouragement and motivation throughout the writing process, as well as for proofreading my paper.

References

(1) Glass, C. K.; Saijo, K.; Winner, B.; Marchetto, M. C.; Gage, F. H. Mechanisms Underlying Inflammation in Neurodegeneration. Cell 2010, 140 (6), 918–934. https://doi.org/10.1016/j.cell.2010.02.016.

(2) Hurley, L. L.; Tizabi, Y. Neuroinflammation, Neurodegeneration, and Depression. Neurotoxicity Res. 2013, 23 (2), 131–144. https://doi.org/10.1007/s12640-012-9348-1.

(3) Anand, S. K.; Ahmad, M. H.; Sahu, M. R.; Subba, R.; Mondal, A. C. Detrimental Effects of Alcohol-Induced Inflammation on Brain Health: From Neurogenesis to Neurodegeneration. Cell. Mol. Neurobiol. 2023, 43 (5), 1885–1904. https://doi.org/10.1007/s10571-022-01308-2.

(4) Basha, F. H.; Hemalatha, S. Screening the Efficacy of Melatonin on Neurodegeneration Mediated by Endoplasmic Reticulum Stress, Inflammation, and Oxidative Damage. Appl. Biochem. Biotechnol. 2022, 194 (3), 1105–1119. https://doi.org/10.1007/s12010-022-03814-x.

(5) Evans, A. K.; Saw, N. L.; Woods, C. E.; Vidano, L. M.; Blumenfeld, S. E.; Lam, R. K.; Chu, E. K.; Reading, C.; Shamloo, M. Impact of High-Fat Diet on Cognitive Behavior and Central and Systemic Inflammation with Aging and Sex Differences in Mice. Brain Behav. Immun. 2024, 118, 334–354. https://doi.org/10.1016/j.bbi.2024.02.025.

(6) Giovannini, M. G.; Scali, C.; Prosperi, C.; Bellucci, A.; Pepeu, G.; Casamenti, F. Experimental Brain Inflammation and Neurodegeneration as Model of Alzheimer's Disease: Protective Effects of Selective COX-2 Inhibitors. Int. J. Immunopathol. Pharmacol. 2003, 16 (2 Suppl.), 31–40. https://doi.org/10.1177/039463200301600205.

(7) Goyal, D.; Ali, S. A.; Singh, R. K. Emerging Role of Gut Microbiota in Modulation of Neuroinflammation and Neurodegeneration with Emphasis on Alzheimer's Disease. Prog. Neuro-Psychopharmacol. Biol. Psychiatry 2021, 106, 110112. https://doi.org/10.1016/j.pnpbp.2020.110112.

(8) Maphis, N.; Xu, G.; Kokiko-Cochran, O. N.; Cardona, A. E.; Ransohoff, R. M.; Lamb, B. T.; Bhaskar, K. Loss of Tau Rescues Inflammation-Mediated Neurodegeneration. Front. Neurosci. 2015, 9, 196. https://doi.org/10.3389/fnins.2015.00196.

(9) Mou, Y.; Du, Y.; Zhou, L.; Yue, J.; Hu, X.; Liu, Y.; Chen, S.; Lin, X.; Zhang, G.; Xiao, H.; Dong, B. Gut Microbiota Interact with the Brain through Systemic Chronic Inflammation: Implications on Neuroinflammation, Neurodegeneration, and Aging. Front. Immunol. 2022, 13, 796288. https://doi.org/10.3389/fimmu.2022.796288.

(10) Tan, B. L.; Norhaizan, M. E. Effect of High-Fat Diets on Oxidative Stress, Cellular Inflammatory Response and Cognitive Function. Nutrients 2019, 11 (11), 2579. https://doi.org/10.3390/nu11112579.

(11) Thomsen, M. S.; Andersen, M. V.; Christoffersen, P. R.; Jensen, M. D.; Lichota, J.; Moos, T. Neurodegeneration with Inflammation Is Accompanied by Accumulation of Iron and Ferritin in Microglia and Neurons. Neurobiol. Dis. 2015, 81, 108–118. https://doi.org/10.1016/j.nbd.2015.03.013.

(12) Wang, J. Y.; Wen, L. L.; Huang, Y. N.; Chen, Y. T.; Ku, M. C. Dual Effects of Antioxidants in Neurodegeneration: Direct Neuroprotection against Oxidative Stress and Indirect Protection via Suppression of Glia-Mediated Inflammation. Curr. Pharm. Des. 2006, 12 (27), 3521–3533. https://doi.org/10.2174/138161206778343109.

(13) Więckowska-Gacek, A.; Mietelska-Porowska, A.; Wydrych, M.; Wojda, U. Western Diet as a Trigger of Alzheimer's Disease: From Metabolic Syndrome and Systemic Inflammation to Neuroinflammation and Neurodegeneration. Ageing Res. Rev. 2021, 70, 101397. https://doi.org/10.1016/j.arr.2021.101397.

(14) Leng, F.; Edison, P. Role of Neuroinflammation in Neurodegeneration Development. Signal Transduction Targeted Ther. 2023, 8, 267. https://doi.org/10.1038/s41392-023-01486-5

Authors

I am a senior in high school with a strong interest in biology, forensic science, and environmental science. Through my academic work, I enjoy exploring how science can be used to understand and solve real-world problems. I am currently undecided on both my college choice and major, and I look forward to exploring these interests further.