Measuring Effect of CCM Proteins on Endothelial Adaptation Under Flow

Assessing How the Understanding of Housewives' Stress Changed Before and After WWII

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

The understanding of stress and its diagnoses in women has been interpreted in many different ways in United States history. For example, understandings of women's stress were very different during World War II (WWII). In correlation with the war, women have assumed various roles in which they supported the United States' efforts–from maintaining the household to sporting a pair of overalls in a mechanic shop. With this sharp change in dynamic, stressors increased from familial to national obligations (Campbell, 1990). This paper aims to address how the definition of stress in women has changed pre and post WWII. I will examine how the expectations of a housewife, transition to becoming a woman in the workforce, and expectation to resort back to housewife responsibilities once the war effort is completed depicts women's stress in the early 20th century. I will also draw correlations from that societal topic to a technical report on cell adaptation under flow.

While shear stress and diagnosed stress are two different terms, they collectively address a change in pressure, whether societal or physical. A major side effect of stress–elevated blood pressure–is used as the link between societal shifts and their physiological impact on a person. For the technical report, endothelial cells are put under flow with the idea to analyze their structural change and adaptation to shear stress. The technical project aims to address how cell junction proteins, specifically the cerebral cavernous malformation protein 1 (CCM1), affect how endothelial cells adapt to changes in flow, mimicking the environment of a cerebral vein. I propose to connect societal factors and how stress is understood in housewives in the STS topic section. To connect these, it is important to visualize the short and long term effects of stress on the body. If stress is not diagnosed or acknowledged, high blood pressure in the brain can lead to cerebral cavernous malformations (CCM), or a lesion in the brain that can lead to death if left

untreated. The core idea behind these topics is to bring recognition to how stress is created and defined, and by bringing recognition to cases from the 1940s, it can be diagnosed and treated more effectively to decrease the physiological effects.

Technical Topic

CCMs are mulberry-like structures in cerebral veins, formed from clusters of small blood vessels in the central nervous system. When they form, the endothelial permeability[1] in the blood-brain barrier increases, disrupting the formation of cell-to-cell junctions and resulting in a greater risk of neurological disorders (Awad, 2019). 1 in 500 people have at least one CCM present, which can lead to inflammation, seizures, headaches, and strokes (Zafar, 2019). CCM proteins form a complex that regulate vascular integrity, stabilize endothelial junctions, and control the permeability of blood vessels (Cavernous, 2023). Mutations in these proteins have been linked to the pathogenesis of CCM, however the mechanisms through which each CCM protein maintains endothelial permeability and prevents CCM formation are still unclear (Riolo, 2021). To address this gap of knowledge, the hypothesis is that CCM1, a main protein in the complex, maintains tight junction integrity when bovine aortic endothelial cells (BAECs)[2] are put under flow. My teammate and I will measure the effect of CCM1 on endothelial adaptation under flow using a parallel plate flow chamber to mimic the physiological conditions of a cerebral vein. We will observe cell structural and orientational changes, and create mutated CCM1 cells to assess cell morphology under flow. We will assess tight junction permeability changes through electrical resistance if time allows. Future iterations of this model may introduce other mutated proteins in cell-to-cell tight junctions, not just CCM1.

[1] the degree to which the barrier of endothelial cells lining blood and lymphatic vessels allows substances to pass through
[2] BAECs are used because they are easy to source, grow quickly, and withstand high shear stress

The first aim of the experiment is to develop a reliable analysis method when comparing cellular shape and orientation changes before and after they have been put under flow. To do this, my teammate and I will create a timeline of when the cells are cultured to when they will be put under flow. We will compare the method of cell shape and size analysis–manual measuring versus automated on the following criteria: reproducibility of results, delivery speed, and accuracy to the orientation of the cell. The second aim, elucidating the role of CCM1 in endothelial cell morphology under flow, will be researched through creating mutated cells with inactive CCM1 proteins. We will compare the control cells with normal CCM1 versus the mutated group after running flow over them. If the cells of the mutated group are not aligned and look dissociated in comparison to the control cells, this verifies that CCM1 is pertinent to maintaining cell integrity between each cell. Finally, time allowing, we will analyze tight junction adaptation with the normal CCM1 cells and the mutated CCM1 cells by running electrical current through the cells. We will measure the electrical resistance of the cell tight junctions, since it is inversely proportional to cell permeability. If the mutated cells have a lower resistance, they are more permeable and the hypothesis is correct.

The significance of this experiment is to evaluate the importance of CCM1 proteins in regulating endothelial structure and permeability under flow, specifically the stabilization of tight junctions and cell adaptation. Future data can be collected regarding other proteins involved in tight junctions as well as other factors, like signaling pathways, affecting endothelial cell permeability with the TEER approach. Identifying specific impact of CCM1 on endothelial cell behavior can lead to therapeutic approaches aimed at stabilizing blood-brain barrier integrity and preventing disease progression in CCM patients. We can extend the methodology developed here to study other tight junction proteins, providing a more comprehensive picture of how

endothelial permeability is regulated and how to analyze it in 2D culture. With this experiment, we will establish a foundation to later address stress-related physiological changes as well as normalize current side effects of stress.

STS Topic

The role of the housewife has been the subject of ongoing societal debate, with the perception of stress associated with this role evolving throughout history. During the early 20th century, during industrialization and feminist movements, there was a rising awareness of "nervousness" among housewives, which was attributed to the changing dynamics of housework, childcare, and marital expectations. Psychiatrist Abraham Myerson offered advice in his book *The Nervous Housewife* on managing this stress, suggesting adjustments to traditional domestic practices as a solution (McLaughlin, 2023). This STS topic explores how societal ideas about housewives' stress have transformed over time, particularly before and after WWII. Examining this historical shift will reveal how societal structures, cultural norms, and technological changes shape the understanding of stress and its impact on particular social groups.

Following WWII, despite women's significant contributions to the workforce during the war effort, societal pressures largely pushed them back into the domestic sphere. Years later, mothers saw a surge in "mommy madness", driven by unrealistic expectations of perfect motherhood fueled by popular culture, expert advice, and socioeconomic realities (Warner, 2005). The rise of the temp industry further complicated this, creating a new category of marginalized employment marketed explicitly to housewives seeking "extra income". This strategy reinforced the notion of women's work as secondary and ultimately encouraged gendered inequalities in the labor market (Hatton, 2008).

While the sources offer insights into historical perceptions of housewives' stress, they do not fully capture housewives' lived experiences and coping mechanisms, or comparisons to their male counterparts. Further research is needed to address how housewives themselves articulated their own experiences and challenges as well as analyze the difference in free time compared to men (Kamp, 2018). Additionally, it is beneficial to examine the long-term consequences of societal perceptions of housewives' stress on women's mental and physical health, career aspirations, and overall well-being.

This research will use a historical and cultural metareview approach to investigate the evolving perceptions of housewives' stress during and immediately after WWII. It will involve examining primary sources, such as self-help literature from the early to mid-20th century, to understand how medical professionals perceived and addressed housewives' nervousness. I will use popular magazines and articles from that period to gauge the cultural discourse surrounding housewives and their perceived struggles. Lastly, I will use archival materials related to the temp industry to understand how this industry strategically targeted housewives, framing their work as secondary and allowing gendered labor inequalities.

I will interpret evidence from the methods listed above to identify how the language used to describe housewives' stress changed over time, reflecting both evolving societal attitudes and medical understanding. I will also analyze causal explanations for housewives' stress, whether individual factors, societal structures, or a combination of both. I will investigate proposed solutions to alleviate housewives' stress, from adjustments within the household to broader societal and policy changes. Finally, I will study media representations, including films like *Rosie the Riveter*, to determine how the experiences of housewives and working women were portrayed (Fishbein, 1982).

Conclusion

Stress continues to be a large factor in the socio-technical realm–from recording data on cell adaptation under shear stress and flow to analyzing stress understandings in housewives in the 1940s. To acknowledge the effects of stress, both physical and psychological, it is important to look to the past and recall situations that evoked a feeling of unease, like societal changes during WWII. With the STS topic analyzing the understandings of stress for housewives before and after WWII, I will scrutinize this pivotal era to provide better background knowledge on the effects of environmental changes to the stress of women. Looking into the effects of stress on the body, such as high blood pressure, the technical topic will assess how endothelial cells will change under shear stress of flow. Once these two topics are completed, the deliverables will contribute to society through providing comprehensive feedback of stress in the 40s as well as visual feedback on cell reaction to stress. These will impact society by normalizing the conversation of how modern day mothers feel and deal with stress along with physical side effects.

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