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Climate health, family-centered care, mental health and biophilic design, women's health

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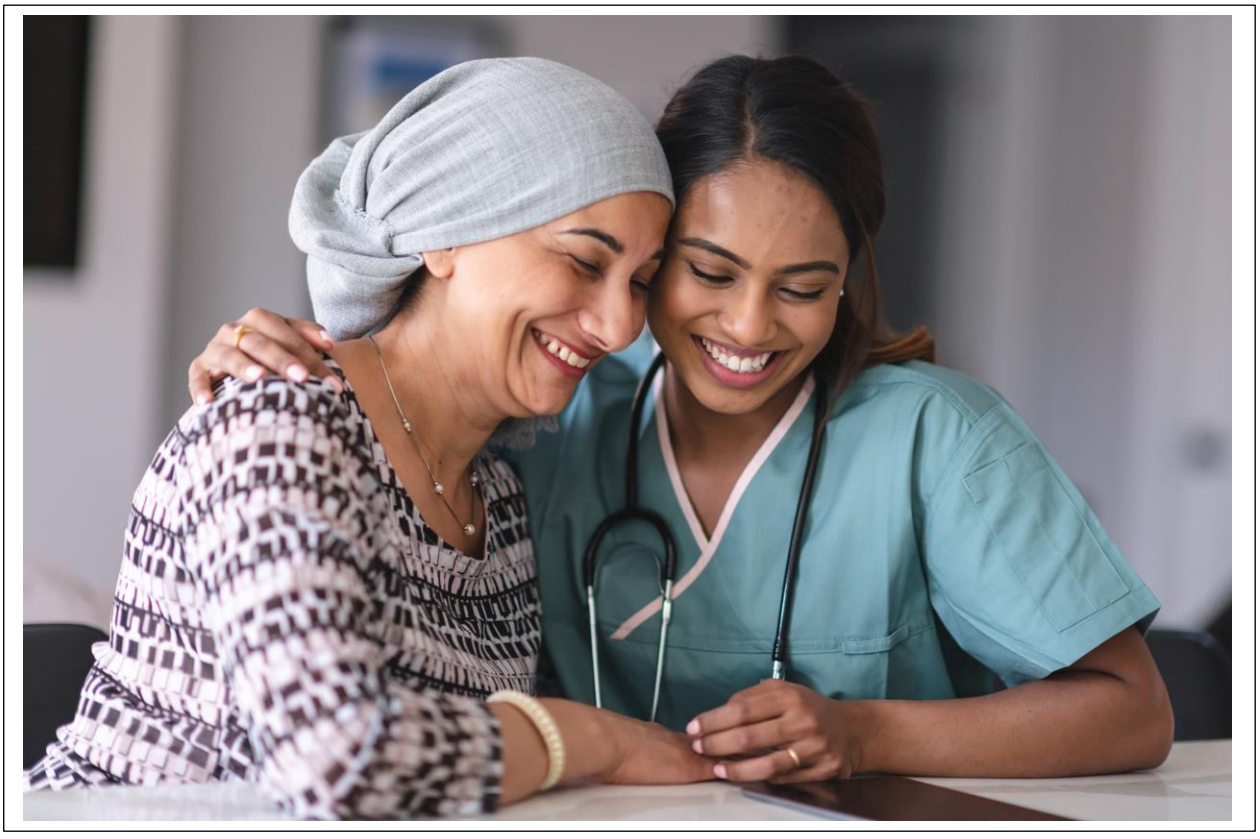
Imran Allarakhia, Senior Editor, International Journal of Social Good and Innovation for Youth.

Patient-Centered Medicine
Empowering premed and medical students to care for the whole patient

Table of Contents



Role of Diet in Gut Dysbiosis: A Cross-Cultural Analysis of Alopecia Areata

Eva Bhattacharya

Introduction: The Pathogenesis of Alopecia Areata

Alopecia Areata (AA) is an autoimmune disease that causes an individual's hair to fall out and can come in many forms: Patchy (patches of hair lost), Totalis (all or near all scalp hair lost), Universalis (full body hair lost, including eyelashes and eyebrows) are significant diagnoses. AA can impact both children and adults, although the triggers and treatment may vary based on age group.

Healthy hair follicles (HF) possess immune privilege in their anagen (growing) phase, which protects the HF from autoimmune attack through many mechanisms like producing immunosuppressive agents. Immune privilege is an evolutionary adaptation that allows specific parts of the body to tolerate foreign substances without triggering destructive inflammatory responses. However, in individuals with AA, more danger signals are relayed to the immune system when healthy HF grows because the body identifies it as a foreign antigen. This results in immune privilege collapse and eventual hair loss as the HF are attacked by the body's own immune system (Azzawi et al., 2018).

Several studies have legitimized the genetic component behind AA, but recent research has also uncovered that it is not a purely genetic trait. Proven by identical twin studies, environmental triggers are certainly involved in its pathogenesis. An identical (monozygotic, MZ) twin study found that MZ twins raised in different environments with different lifestyles and households, did not develop the same autoimmune diseases, which is referred to as MZ twin discordance. Because MZ twins share nearly all of their DNA, the difference in developing autoimmune disease can be attributed to the different environments they grew up in (Bogdanos et al., 2012). Among several others including psychological stress and, intriguingly, circadian rhythm of drug administration timing (inflammatory pathways and T-cell activity are higher at night), a crucial factor is nutrition (Minokawa et al., 2022; Liu et al., 2023).

Focus: The Role of Traditional Diets vs. Western Diet

Traditional diets can be defined as an umbrella term for any high-fiber, unprocessed diet — the whole-food, plant-based diet (WFPB); Mediterranean diet (MD); vegan and vegetarian diets; and Paleolithic with fiber diets. The MD, for example, was featured in the Italian National Guidelines, and found to be "associated with reduced inflammation and improved immune regulation" (Gianfredi et al., 2026). Similarly, a study on the autoimmune disease Inflammatory Bowel Disease (IBD) that replaced IBD patients on a Western diet with a plant-based one, revealed that mild Ulcerative Colitis (a type of IBD) can be effectively treated through this diet change, rather than medication (Chiba et al., 2019).

Although a similar study on AA patients has not been done to extend the effects of a traditional diet on hair loss, it may be reasonable to assume that these diets can foster a healthy gut microbiota and reduce inflammation, consequently improving AA effects. Additionally, the connection between the Western diet and AA is heavily supported (Rinaldi et al., 2019).

This association is multifactorial: alcohol consumption, smoking, and processed carbohydrates are all risk-factors for AA pathogenesis, but the focus in this article will be on fatty acids and obesity. Omega-3 and Omega-6 fatty acids are two molecules that are highly associated with autoimmunity because of their impact on inflammation in the body. Omega-3 intake is a risk-reducer for inflammatory diseases, like AA, which has been proven by several epidemiological studies. Omega-3 is strongly present in vegan and whole-food, plant-based (WFPB) diets because it exists in relatively high amounts in seafood and plants. Because Omega-3 is good to prevent autoimmune disease pathogenesis, many professionals recommend a traditional diet to adequately intake this fatty acid. On the other hand, Omega-6 intake is associated with an increased development of autoimmune diseases. AA was explicitly tested in relation to these molecules, and the effects of the above studies corresponded. Increasing Omega-6 intake showed an increase in autoimmune disease pathogenesis (Blasbalg et al., 2011). This direct relationship may be attributed to the Western diet as well because Omega-6 is found in soybean, corn, and canola oils which dominate processed and fried foods as well. Further, there has been an increase in Omega-6 consumption in the United States during the 20th century because of its abundance in the Western diet. It has been suggested that the increased rates of autoimmunity like AA can be partially tracked to the Omega-6 fatty acids present in Western diets (Lerner & Matthias, 2015).

On a larger scale, obesity is associated with the pathogenesis of AA and autoimmune disease. Some professionals argue that targeting obesity as the overall issue would be more effective than targeting individual nutrients even though the exact reason it exacerbates AA is unclear. Obesity naturally predisposes individuals to many chronic issues but specifically links to inflammatory diseases because of numerous immune responses, such as Th17 (Type 17 helper T cell) and Th1 (Type 1 helper T cell), that depend on subcutaneous fat levels (Minokawa et al., 2022). For example, the Th1 immune response is a defense mechanism that helps eliminate intracellular pathogens. When an individual is obese, the excess fat tissues recruit Th1 to release inflammatory cytokines, which causes white blood cells to migrate into surrounding tissues. Down the line, this T-cell driven inflammation can play a role in AA pathogenesis as it damages gut barrier functions (Rocha et al., 2008). Additionally, Western diets are highly caloric and less satiating because they include refined grains, added sugars, and saturated fats, which can cause obesity. Worth noting is that there has been an increase in people from developing nations developing the same rates of autoimmune disease as Americans, which is seemingly parallel to the Westernization of these nations (Bingham Healthcare, 2017). Because of this, it may be reasonable to point to the Westernization of their diets as one factor causing the increased autoimmunity.

Synthesis: The Correlation between Western Diet, Gut Dysbiosis and Alopecia Areata

Gut microbiome dysbiosis simply stated is a change from the normal. It occurs when the normal balance of gut microbes shifts because of space competition and results in the ratio of bacterial classes deviating from normal. Dysbiosis in itself is a vague term, which does not describe the microbiome landscape specifically, but rather just points out the differing ratios. In the case of AA, there is a general overrepresentation of the dominant phyla firmicutes (F) and underrepresentation of bacteroidetes (B) (Lee et al., 2024). The F/B ratio can be helpful

in understanding the overall health of an individual's gut microbiome. A lower/balanced ratio is generally associated with lean body mass and healthy intestinal function, but an elevated ratio is linked to obesity and metabolic disorders.

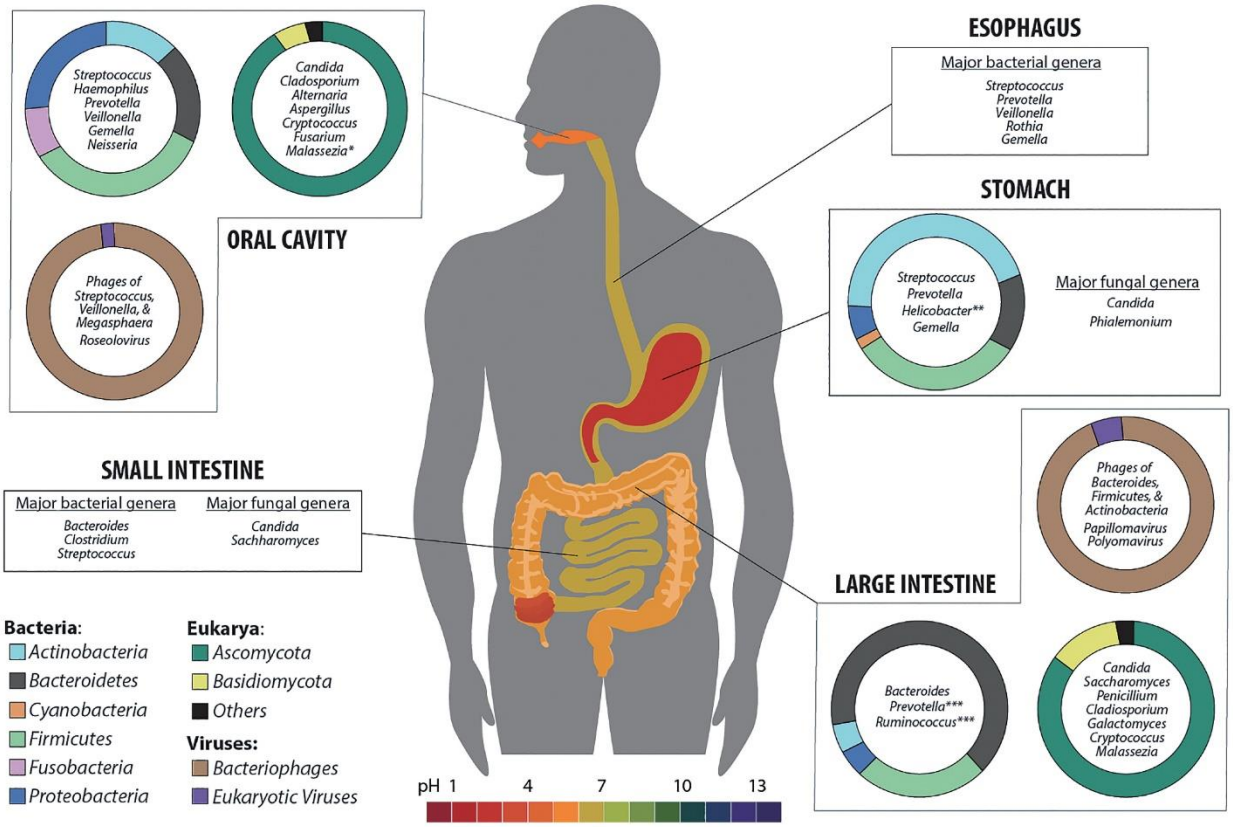


Figure 1: Human Gut Microbiome (Source: Wikimedia, License: Creative Commons)

This imbalance can be harmful in AA cases because it exerts effects on the gut itself by increasing intestinal permeability, which is more commonly known as "leaky gut" (Lerner & Matthias, 2015). In fact, patients with AA often have elevated claudin-3 plasma concentrations (a biomarker of intestinal barrier integrity) which has been shown to correlate with the severity of their hair loss (Severino et al., 2025). This increased permeability can allow surrounding substances to cross the gut lining and unnecessarily alert the immune system. Even though this may seem like a solely localized change, the effects can spread widely, as seen in patients with AA.

One of the first significant findings emerged through an exploration of the link between AA and gut dysbiosis in mice at Columbia University. Researchers who depleted the gut microbiome from mice saw that it protected them from developing AA and therefore were able to conclude that the gut microbiome is required for the induction of AA (Nair et al., 2017).

Given the emerging connection between AA and gut dysbiosis is starting to be established, further research can support the impact of Western diet on gut dysbiosis to allow us to understand how AA and the Western diet may be related down-the-line. Although studies have not been able to successfully prove a link between obesity and a changing F/B ratio, they have established that individuals on a Western diet have different F/B ratios than those on a "healthy" (MD, vegan, plant-based) diet. Furthermore, these F/B ratios are increased in obese individuals on the Western diet, which corresponds to the increased F/B ratios in AA patients (Clemente-Suárez et al., 2023). Although there is not much research backing that supports the link between an elevated F/B ratio and AA pathogenesis directly, the F/B ratio should certainly not be discounted as an indicator of gut microbiome dysbiosis specific to AA patients. The increased F/B ratio is representative of the gut dysbiosis which occurs in individuals with AA and is directly influenced by the types of foods in the Western diet.

Conclusion

A Western diet is associated with autoimmunity and by extension may be a significant environmental factor in the pathogenesis of AA. While attending the 41st annual National Alopecia Areata Foundation conference, Dr. Angela Christiano who has pioneered various breakthroughs in AA treatment, such as JAK inhibitors and microbiota transplant therapy (MTT), presented the Swiss cheese model of accident causation which perfectly sums up the pathogenesis of AA. A variety of genetic and environmental factors have to align in a certain way for AA to arise in an individual and while research continues on this specific alignment, one thing seems certain: the Western diet plays a significant role in AA pathogenesis.

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How Can Play And Hands-On Creative Activities Support Emotional Health In Hospitalized Children?

Aishani Shah

Introduction

Imagine being an eight-year-old child, restricted to a hospital bed and surrounded by unfamiliar, intimidating machines. You are scared, stressed, and in pain as you wait for your next IV, scan, or procedure. While children your age attend school, play sports, and spend time with friends, your life becomes centered around months of treatment. For many children, the fear of long hospital stays goes beyond medical issues but also to emotional challenges such as loneliness, boredom, and separation from an important part of childhood: play. Research shows that play is essential for a child's development, and in hospital settings it is limited (Koukourikos et al., 2015). Although there are less opportunities, play can still be incorporated into the hospital environment to support children's needs. For school-age children, play can take many forms, including arts and crafts, group activities, and hands-on creative expression. Bracelet-making kits are an effective solution because they are a fun and creative activity that helps children express their emotions and feelings they are experiencing. As a result, incorporating engaging activities into pediatric care settings can be very important in reducing stress and anxiety of patients and improving the emotional well-being of hospitalized children (Signorelli et al., 2023).

How Long Hospital Stays Increase Anxiety

Children in the hospital often feel very anxious, bored, and afraid of what might happen to them next. Research shows that hospitalization is a highly stressful experience for children, leading to significant increases in anxiety and negative emotions, especially when they undergo painful medical procedures (Li et al., 2016). Studies have found a relationship between the duration a child stays in the hospital and their anxiety level. The longer a child stays in the hospital, the more likely they are to experience anxiety at a high level, as long hospitalization disrupts their daily lives and separates them from familiar surroundings (Mîndru et al., 2016). As one study on extended pediatric hospitalization explains, admitting a child to the hospital means "interrupting his or her normal daily life and changing the environment that is familiar to him or her," which can leave children feeling isolated from normal child activities (Mîndru et al., 2016). This is exactly why emotional support activities are crucial. When children feel overwhelmed by the hospital environment and cut off from their normal world, it can negatively affect their mood, their willingness to cooperate with medical treatment, their recovery process, and even how they interact and communicate with caregivers and family members (Commodari, 2010).

How Creative Activities Help Children Express Feelings

Creative activities such as art therapy and therapeutic play give children a direct way to express their feelings and deal with illness especially when they might not want to or have the energy to verbalize their emotions. Research shows that play therapy and creative play interventions decrease pain, improve behavior and attitude, and reduce anxiety in hospitalized

children (Li et al., 2016; Godino-Iáñez et al., 2020). A study of hospitalized children found that art therapy helped them feel safe and relaxed, allowed the patients to see themselves as "artists, not patients," and led to more smiling, laughing, and acting like their usual healthy selves (Siegel et al., 2016). These activities give children a safe and engaging way to process what they are going through. Additionally, it allows them to express emotions such as fear, anger, or confusion through creative work without having to talk directly about it.

Additionally, creative activities in a group can enable a space where children can connect with each other over their challenges and feel supported by others going through a similar journey. Overall, creative and art-based activities act as a safe space for expression of thoughts and feelings which can help children in the hospital cope with the long recovery process.

How Hands-On Activities Build Confidence and Control

Additionally, hands-on activities can help children build confidence and mental strength as they undergo long painful treatment. The act of making things with their hands helps children feel capable and in control because they get to choose colors, patterns, and designs in a space where they often have little or no control of the outcomes and what happens next (Koukourikos et al., 2015). Research specifically shows that making jewelry from beads lowered anxiety in children with cancer. In a randomized controlled study, children aged 7–18 who made jewelry from beads twice a week for four weeks had significantly lower state anxiety after the first week and after the fourth week compared with children who did not do the activity. The study concluded that the activity of making jewelry from beads was effective in reducing the state and trait anxiety levels of children with cancer (Günay et al., 2022). This concludes that hands-on activities, and in particular, bracelet-making, have a measurable impact in helping children feel calmer and more confident. Just like the jewelry in the study, bracelets are something children can design, create, and wear as a symbol of what they were able to overcome, reminding themselves that they are strong, capable and brave

How Playing with Others Reduces Loneliness

Children cope better in the hospital when they have opportunities to play with others, because shared activities help them feel connected instead of alone, which is a common experience in a hospital room. Playing with other children allows them to express their feelings, communicate with peers their age, and form bonds with others who understand what they are going through (Koukourikos et al., 2015). Research shows that interacting through play with peers can reduce anxiety and negative emotions, suggesting that shared play is not only enjoyable but also an important coping tool (Li et al., 2016). A review of creative group play interventions found that engaging with others can improve children's mood, comfort, and willingness to participate in treatment (Signorelli et al., 2023). Additionally, involvement from parents,

caregivers, or even volunteers during these shared activities helps children feel less isolated. Group activities such as drawing together, playing games, or creating crafts encourage children to build trust, communicate more openly, and feel more at ease in the hospital environment. Playing alongside other hospitalized children also gives them a safe space to talk about their emotions with someone who truly understands their experience. Overall, playing with others helps children adjust to hospitalization by providing social connection, emotional support, and a stronger sense of belonging.

Why Bracelet-Making Is An Effective Solution

As a result, bracelet-making is a strong intervention for hospitalized children because it combines play, creativity, and hands-on expression in a simple activity that fits the hospital setting. Research shows that play-based interventions can reduce anxiety, pain, and negative emotions in hospitalized children while also improving cooperation and behavior during care (Li et al., 2016; Godino-Iáñez et al., 2020; Signorelli et al., 2023). A bracelet is especially useful because it gives children real choices about colors, patterns, and designs, which can help them feel more in control during a time when much of their treatment is decided for them. Making a bracelet can also be calming, giving children something focused and soothing to do with their hands, while the finished bracelet can serve as a reminder of support that they can look at or touch when they feel scared, lonely, or overwhelmed. In addition, if children make bracelets together, the activity can support connection, conversation, and comfort with other children who understand what they are going through. Bracelet-making kits that allow children to make bracelets for themselves and for their loved ones can strengthen connection and give both children and parents a shared, positive activity in the hospital, which fits well with patient- and family-centered care (Günay et al., 2022).

Conclusion

To conclude, long hospital stays are hard for children because they often bring fear, pain, stress, and an absence of their normal routines. Research on hospitalized children shows that play-based activities can reduce anxiety, pain, and negative emotions, while also improving behavior and comfort during care (Li et al., 2016; Godino-Iáñez et al., 2020). Creative activities give children a chance to express feelings, make choices, and feel more in control in a setting where much of their day is already decided for them. This is why bracelet-making is a strong idea: it is simple, low-cost, and hands-on, but it also gives children something meaningful to create and keep. Studies on bead jewelry making found that this kind of activity can lower anxiety in children with cancer, showing that even small creative tasks can have a real effect (Günay et al., 2022). Bracelet-making kits can help children stay busy, feel calmer, and make something personal that reminds them of support and strength during a difficult hospital stay.

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Biophilic Design in Healthcare

Sreerachana Manthati

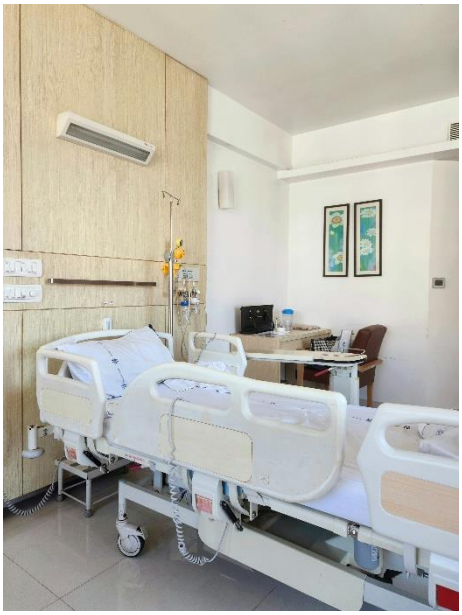
Introduction

When thinking about the quality of healthcare, what comes to mind for most people is how they are treated by healthcare workers, how well their needs are addressed, how well they recovered and how easy the process was. However, another important consideration that many might not think actively about is their healthcare setting, even though the environment surrounding someone can play a role in their recovery. Biophilic design, which seeks to unite nature with human infrastructure, is a simple way to improve patient outcomes by bringing in aspects of nature into a hospital environment. Even if a patient does not think about how much sunlight enters their room or about a small potted plant near their bed or about the wooden flooring and warm colors in the room, all of these seemingly trivial details can subconsciously and positively influence their hospital experience.

The idea that nature has restorative and mood-boosting effects is certainly nothing new– it is a concept that has been around since ancient times, as seen for instance in the architecture of the ancient Greeks' Asclepeions, or healing temples, which were located away from urban areas and near sources of freshwater and natural beauty (Tekin et al., 2022). And today, many recreational and therapeutic activities still include spending time interacting with nature, or are nature-based, from hiking to aromatherapy. Even in everyday contexts, just simply taking a walk outside might help one clear their mind and ease their anxieties.

It's no coincidence that nature seems to improve someone's mood. And biophilic design has indeed been shown to improve outcomes for patients, helping them in both physiological and psychological ways. Designs incorporating nature have been associated with lower patient heart rates, "small to medium reductions in cortisol levels", and are connected to reductions in "opioid or other pain medication use" in postoperative care (Du et al., 2026). Daylight helps the body regulate its circadian rhythm and allows patients to sleep better, which contributes to their recovery. Patients also experience lower anxiety levels and experience "faster emotional recovery" which help increase trust in healthcare providers and cooperation during treatments and thus, shorten hospital stays (Du et al., 2026). Patients who are comfortable and content are in a more stable emotional state than those who are not, which would likely result in more effective patient-provider interactions, minimizing stress for both parties. Furthermore, many of the effects of biophilic design are not limited to patients alone-staff and family members may also feel more at ease and satisfied as a consequence of biophilic design. Interestingly, the waiting room has been shown to have the "greatest potential to apply biophilic strategies" when compared to other areas of a hospital (Miola et al., 2025).

As for integrating biophilic design into hospital settings, there are a variety of methods to do so, ranging from adding decorative plants to rooms to using projections and virtual reality to simulate nature– but all elements of biophilic design are intended to fulfill the "human connection to nature" (Tekin et al., 2022).



In fact, some of us may have already encountered healthcare spaces using biophilic design if we have ever encountered colorful fish tanks at a dental office or paintings of plants or animals used to decorate waiting rooms.

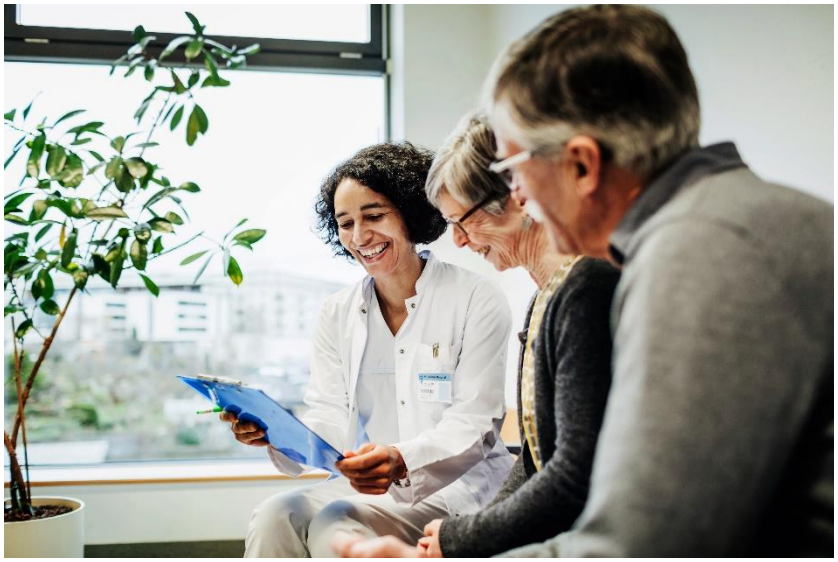
If hospitals hope to make use of biophilic design, Du et al. (2026) suggest that they could consider adding gardens, terraces, or courtyards to provide areas for patients to interact with nature, as well as promote social interaction and movement. Patient rooms can be structured so that windows provide views of the landscape and allow ample sunlight into the room, for those who may not be able to move as freely as other patients. The usage of natural materials–such as wood or stone–alongside natural color palettes can also make a difference.

On the other hand, if it is impractical for hospitals to repaint many of their rooms or create a garden–biophilic design elements that would be easier to implement if planned out when a hospital building is still being designed–simulations and virtual reality may be an alternative way to allow patients to experience nature (Du et al., 2026). For bedbound patients, virtual reality is an especially useful tool as it does not require them to move to another area to be exposed to nature, while projections can be utilized in rooms lacking windows. Playing "gentle nature sounds" also helps with creating "multisensory therapeutic experiences" (Du et al., 2026).

While both the presence of real nature and simulations provide the same positive effects, it is worth noting that exposure to real nature has stronger effects (Du et al., 2026). However, when exposing patients to real nature, some considerations must be taken to ensure that it won't have any adverse effects on them, as patients are already in a vulnerable state. There is the concern that patients might be infected by "fungal or bacterial pathogens released from soil" (Miola et al., 2025). Vase water may also be a potential reservoir for pathogens. Yet, as of current, there is not a "clear link between microorganisms in plant soils or vase water and hospital-acquired infections" (Miola et al., 2025). Patient allergies, on the other hand, are another factor. Patients may have plant and pollen allergies that should be taken into account, and therefore "low-allergen species" should be selected (Du et al., 2026).

Various healthcare facilities around the United States have incorporated biophilic design, such as **Cincinnati's Children's Hospital in Ohio**, which has a Critical Care Building with "four distinct outdoor spaces" for different people who might be at the hospital-healthcare workers, visitors, and patients (Nyren). Terraces and gardens make up these outdoor spaces, and the building has been designed to "[bring] in daylight and views to the outdoors" (Nyren).

The **MarinHealth Medical Center in California** takes a similar approach by using gardens and large windows to provide patients with views of natural scenery (Nyren). Patient rooms feature "floor-to-ceiling windows" to admire the "gardens, wetlands, and nearby Mount Tamalpais".



And **Texas Health Frisco** also uses elements of biophilic design, albeit in a different way. The building itself is inspired by "Texan geological formations" and its concrete facade mimics the "shape and surface of rocks" (Nyren). There are multiple walking trails and even a "pocket park". Furthermore, the "native prairie grasses" that make up most of the landscape do not require watering.

Many of us can perhaps link some of our happiest memories with time spent in nature– racing outside with friends down a hill, playing in the sand at a beach, watching with fascination as butterflies land on flowers. Nature is frequently associated with memories of freedom, adventure, excitement. Some of our poignant moments might have also been spent in nature–watching the sun sink beneath the horizon, looking at the view from a mountaintop, seeing a small storm brewing in the distance. Nature brings feelings of satisfaction and relaxation as well.

It would make a difference to bring these moments of joy and contentment to patients in a hospital, as a gentle reminder that despite their situation, there is much beauty to behold in the world.

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Patient Involvement in Women's Healthcare: A Comparative Analysis of the United States and Vietnam

Katie Nguyen

Abstract

Patient involvement means women get a real say in their own healthcare decisions. This paper looks at how women make choices about contraception and reproductive health in the United States versus Vietnam. I researched published studies, national surveys, and health system data, plus I got firsthand perspective from my internship in Ho Chi Minh City. Here's what I found: the US and Vietnam handle patient involvement totally differently. In the US, we say women should make their own choices, but here's the problem — only 30% of women actually feel like they have enough information to make that choice. In Vietnam, decisions are made as a family, with doctors in charge, shaped by the culture being more collectivist and hierarchical. Vietnam has really high contraceptive use (73%), but that comes from a provider-led system, not from women choosing between options. The key finding: neither system is perfect. Both have gaps, just different ones. The US has an information gap. Vietnam has limited space for individual voice. But they can learn from each other. Vietnam could use better counseling tools. The US could involve families more. This comparison shows that "good patient involvement" doesn't look the same everywhere — it depends on culture and context.

Introduction

When a woman chooses a contraceptive method, decides how she will give birth, or weighs whether to be screened for cervical cancer, she is making what researchers call a preference-sensitive decision: more than one option is medically appropriate, so the best choice depends on her own values, circumstances, and priorities (Dehlendorf et al., 2017). How much voice she has in these decisions varies dramatically across health systems. In some settings, the patient is treated as the lead decision-maker, with the clinician acting as an advisor. In others, the physician, or the patient's family, is expected to decide on her behalf. This paper compares patient involvement in women's healthcare between the United States and Vietnam. The comparison is meaningful for several reasons. The two countries sit at nearly opposite ends of established cultural dimensions relevant to medical communication: the United States is among the most individualist societies measured, while Vietnam scores highest on power distance and lowest on individualism, meaning patients tend to accept a hierarchical order and rarely view doctors as partners (Tran et al., 2020). The two systems are also structured differently, with different insurance arrangements, facility loads, and legal frameworks for patient rights. Finally, the author's perspective is informed by a healthcare internship in Ho Chi Minh City, which motivated the choice of Vietnam as a comparison country and provided firsthand context for interpreting the published literature.

Research Question and Methods

How do women's roles in family planning and reproductive health decisions differ between the United States and Vietnam, and what factors shape their level of involvement?

This study is a comparative literature review. Sources were identified through PubMed, PubMed Central, Scopus-indexed journals, and Google Scholar using combinations of the terms shared decision-making, patient participation, contraceptive counseling, doctor-patient communication, respectful maternity care, United States, and Vietnam. National statistics were acquired from the CDC National Survey of Family Growth, the Kaiser Family Foundation Women's Health Survey, the General Statistics Office of Vietnam, and UNFPA program reports. Health system context was drawn from the Commonwealth Fund international profiles and peer-reviewed analyses of Vietnam's insurance and hospital systems. Preference was given to peer-reviewed, open-access studies published within the last fifteen years. Observations from the author's internship in Ho Chi Minh City were used only as background context to inform framing and interpretation; no patient data were collected, and no identifying information is included. This design has inherent limitations, which are discussed later.

Conceptual Framework: What Counts as Involvement?

When researchers talk about patient involvement, the most common model is called shared decision-making (SDM). The basic idea is simple: the doctor brings medical knowledge (what's safe, what works), and the patient brings knowledge about themselves (what matters to them, what fits their life). They work together on the decision.

There's actually a three-step process for how this works: First, choice talk — the doctor makes it clear that more than one option exists. Second, option talk — the doctor and patient explore the different choices and what each one means. Third, decision talk — they make the decision together (Nieuwenhuijze et al., 2014). Researchers have created surveys and scales to measure whether this actually happens, like the SDM-Q-9 and the Mothers' Autonomy in Decision Making scale (Vedam et al., 2017).

But here's an important point: involvement doesn't always mean the woman decides alone. The World Health Organization looked at 67 studies from 32 countries about respectful maternity care (Shakibazadeh et al., 2018). They found that quality care includes: giving women information, getting their informed consent, communicating effectively, and respecting their choices. But it also includes supporting women's family and community connections. This matters for my research because it means a woman can be genuinely involved in a decision even if her family is part of the process. You don't have to choose alone to have a real say.

The United States

American clinical ethics and law increasingly frame the woman as the lead decision-maker in reproductive care. Professional guidance calls for patient-centered contraceptive counseling built on shared decision-making, and a growing number of states apply a patient viewpoint standard requiring clinicians to disclose whatever a reasonable person in the patient's position would want to know (National Partnership for Women & Families, 2024). Research on women's stated preferences supports this design: the vast majority of American women feel it is appropriate that they make the final decision about their birth control method, though about half also want active input from their provider, supporting a shared rather than purely independent model (Dehlendorf et al., 2013).

Practice, however, falls short of the ideal in two directions. First, information does not reach patients reliably. Although over 90 percent of American women of reproductive age report choosing to use contraception, only 30 percent said in a 2022 national survey that they had the information they needed to make contraceptive decisions (Chen et al., 2023). Current contraceptive use stood at 54.3 percent of females aged 15 to 49 in 2022-2023, with female sterilization, the pill, and long-acting reversible contraceptives the most common methods (Daniels & Abma, 2025). Second, provider influence remains strong: over half of women

report that their provider influenced their choice of method, and many report that their concerns about side effects were not sufficiently considered (Dehlendorf et al., 2018). Women who experience genuine shared decision-making are more satisfied with both their counseling and their chosen method than women who experience either provider-driven or entirely patient-driven decisions (Dehlendorf et al., 2017).

The shortfall is starkest in maternity care. In the Giving Voice to Mothers study, the first community-designed national survey of childbirth experiences, one in six American women (17.3 percent) reported mistreatment such as loss of autonomy, being shouted at or threatened, or having requests for help ignored; rates were substantially higher in hospital births than home births and consistently higher for women of color (Vedam et al., 2019). Given this gap, the US healthcare system needs to address involvement as well as its unequal and incomplete delivery.

Vietnam

Vietnam presents a different architecture of decision-making. Culturally, a nationwide survey of 480 patients and 473 doctors found that Vietnam's high power distance and low individualism mean patients accept a hierarchical order, do not think of doctors as partners, and that Western partnership models of communication require adaptation before they fit the Vietnamese context (Tran et al., 2020). Qualitative work with Vietnamese patients similarly reports that patients see the doctor's role as curing rather than partnering, and that open doctor-patient conversation has not traditionally been part of the culture (Nguyen et al., 2022). Discourse analysis of primary care visits adds a distinctive finding: doctors and patients routinely invoke family members as third parties in consultations, and a relative's opinion can outweigh a medical professional's, reflecting collectivism and the social weight of family (Nguyen & Le, 2018).

The structure of the health system reinforces these patterns. Out-of-pocket payments account for roughly 40 percent of total health spending, and quality gaps between facility levels drive patients to bypass local clinics for overcrowded central hospitals in Hanoi and Ho Chi Minh City (Nguyen & Pham, 2021; Commonwealth Fund, 2026). Overcrowding compresses consultation time, structurally limiting how much counseling any clinician can provide. Vietnamese law formally grants patients the right to informed consent and access to medical records, but observers note persistent challenges in ensuring these rights in practice, an important gap between formal law and lived experience.

Family planning history also shapes involvement. Vietnam's national program achieved high contraceptive coverage, with 73 percent of married women using some method. Approximately, 59.8 percent using modern methods as suggested in the 2020-2021 SDGCW national survey, and the IUD still the single most common method at 23.7 percent. However, it did so by concentrating heavily on a single method, the intrauterine device, which for decades restricted the real range of options from which women could choose (Guttmacher Institute, 1995; UNFPA/GSO, 2021). High prevalence, in other words, is not the same as high involvement: a woman can be a contraceptive user without ever having weighed alternatives.

Yet Vietnamese women clearly exercise agency, channeled through family and culture. Studies of birth-mode preferences show that women's choices are shaped by relatives' advice, provider recommendations, the availability of family support during labor, and folk beliefs that a child's destiny is influenced by its birth date and time, a belief that has contributed to rising cesarean rates in urban centers (Nguyen et al., 2025). Vietnam's national cesarean rate reached 34.4 percent in 2021, more than double the WHO-recommended range, and urban rates reached 43 percent as early as 2014 (Takegata et al., 2020; Nguyen et al., 2025). In preventive care, only about a quarter of Vietnamese women report ever being screened for cervical cancer, yet 85 percent say they would screen if a healthcare professional recommended it, and older women frequently make screening and vaccination decisions on behalf of younger family members (Tran et al., 2023). Involvement in Vietnam is real, but it is collective, deferent, and mediated, rather than individual and autonomous.

Comparative Analysis

Figure 1 places headline contraceptive statistics side by side. In the most recent national surveys, 54.3 percent of American females aged 15 to 49 were currently using contraception (2022-2023), compared with 73 percent of married Vietnamese women using any method and 59.8 percent using modern methods (2020-2021); notably, 72.2 percent of married Vietnamese women's demand for family planning is satisfied with modern methods. Vietnam's prevalence among married women exceeds the American all-women figure, a reminder that access and uptake are not the dimensions on which the two systems most differ. The populations also differ (all US females versus married Vietnamese women), so the gap should be read as indicative rather than exact.

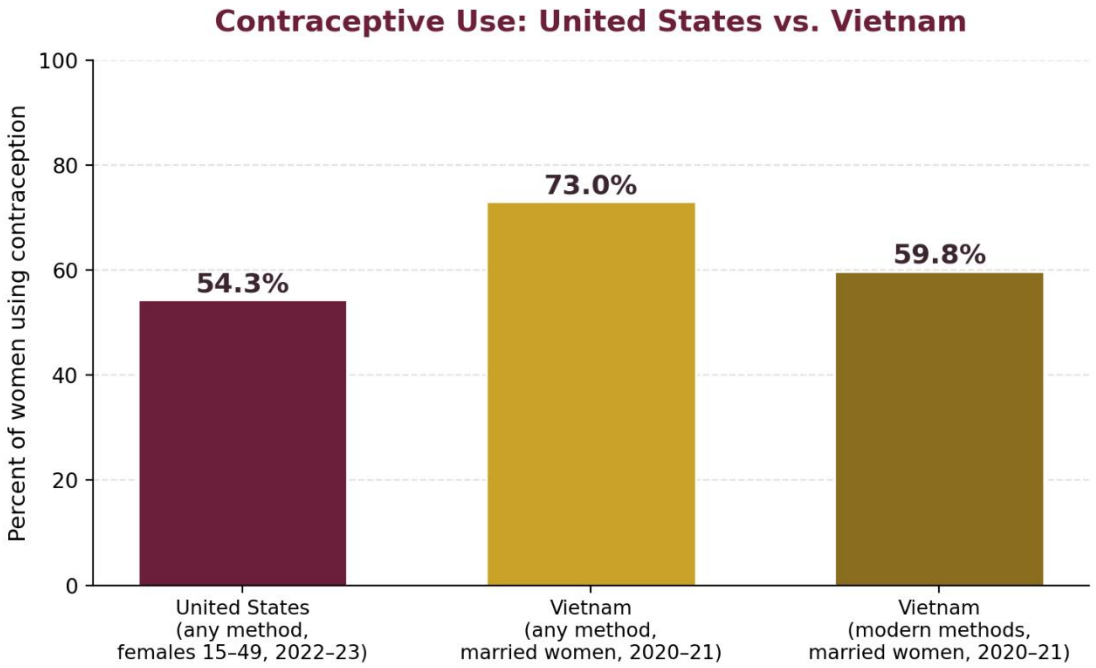

Figure 1. Contraceptive prevalence in the United States and Vietnam. Sources: CDC/NCHS NSFG 2022-2023 (Data Brief 539); UNFPA/GSO SDGCW Survey 2020-2021.

Where the systems diverge is in the process of deciding, summarized in Figure 2. In the United States, the binding constraint is information and undue provider influence within an autonomy-centered model. In Vietnam, the binding constraints are hierarchy, consultation time, and a historically narrow method mix within a family-mediated model, but provider recommendation is also the single most powerful lever for action, as the screening data show.

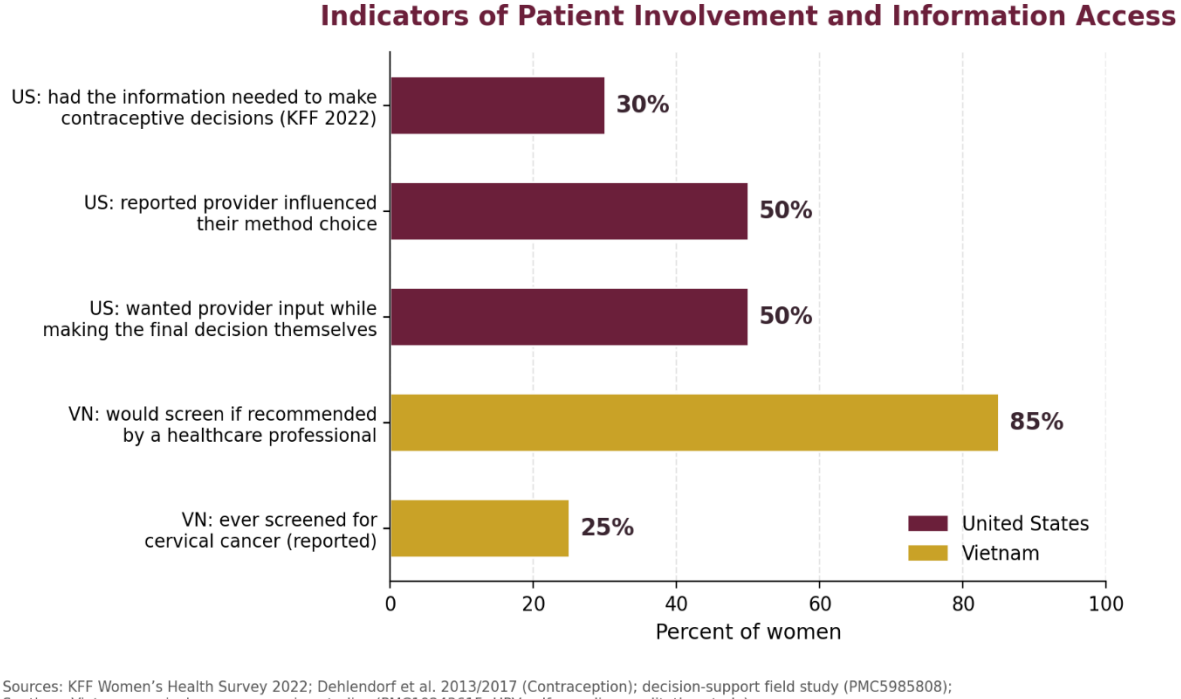

Figure 2. Selected indicators of information access and involvement. Sources: KFF 2022; Dehlendorf et al.; Southern Vietnam screening studies.

Figure 3 uses cesarean rates as a window into birth decision-making. Both countries exceed the WHO-recommended range, but for different reasons documented in the literature: in the United States, where the cesarean rate reached 32.4 percent of births in 2024, unexpected obstetric intervention and patient-provider disagreement are associated with reported mistreatment and loss of autonomy, while in Vietnam elevated rates are driven substantially by non-medical preferences, including family advice and auspicious birth timing, that providers accommodate.

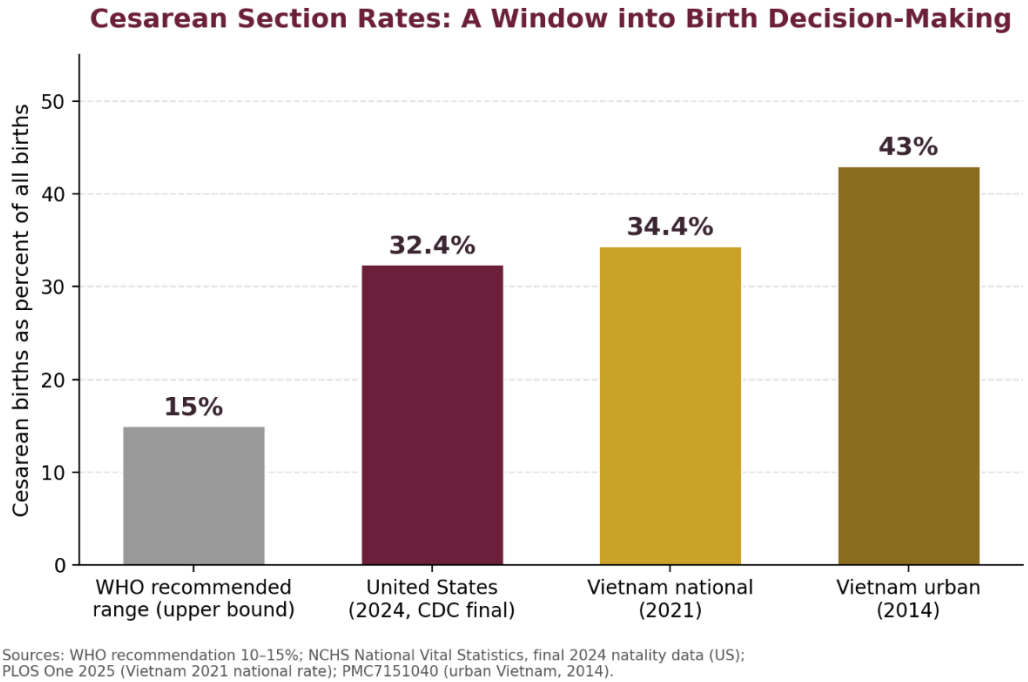

Figure 3. Cesarean section rates against the WHO-recommended range. Sources: WHO; NCHS final 2024 natality data; PLOS One 2025; PMC7151040.

Three factors explain the observed differences. The first is cultural: individualism versus collectivism, and low versus high power distance, which set expectations about who decides. The second is structural: consultation time, facility crowding, insurance design, and out-of-pocket burden, which determine how much counseling is physically possible. The third is historical and programmatic: the American legal evolution toward patient-viewpoint disclosure standards versus Vietnam's method-concentrated national family planning program. Together these produce two distinct gaps: an American gap between the autonomy ideal and its unequal delivery, and a Vietnamese gap between formal patient rights and a practice environment that leaves little room for individual deliberation.

Limitations

This analysis is a literature review, not original data collection, and cross-country statistics are not always directly comparable: American contraceptive figures cover all women aged 15 to 49, while Vietnamese figures typically cover currently married women. The English-language literature on Vietnamese women's involvement in healthcare decisions remains thin, so some conclusions rest on a small number of studies. Internship observations are anecdotal, drawn from a single urban setting, and were used only for framing. Finally, both health systems are changing rapidly, and several cited statistics pre-date the most recent policy reforms in each country.

Conclusion

Women's roles in reproductive healthcare decisions differ between the United States and Vietnam not primarily in whether women are involved, but in how. The American model locates the decision in the individual woman and supports it with legal disclosure standards and shared decision-making tools, yet it under-delivers information, permits substantial provider influence, and distributes respectful treatment unequally. The Vietnamese model locates the decision in a web of family, provider, and cultural meaning, achieving high service uptake while offering limited space for individual deliberation, constrained by hierarchy, crowding, and a historically narrow method mix.

Neither model is simply better. Vietnam's family-inclusive care contains something American maternity systems are criticized for lacking, while the American toolkit of decision aids, counseling frameworks, and patient-rights standards addresses exactly the information and deliberation gaps documented in Vietnam. Improving involvement in both countries points in the same direction: structured counseling that elicits women's own values, affordable and genuinely plural options, and communication training that respects, rather than replaces, the cultural context in which women decide. For a health system, as for a family, respecting a woman's voice is not a single policy, but a daily practice, and both countries are still learning it.

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Whole Patient Care: Treating Emotional Health as Part of Chronic Disease Care

Eva Yadav

Introduction

Chronic illness affects emotional well-being not only through pain, fatigue, and treatment demands, but also through loss of control, altered identity, uncertainty, and social isolation; therefore, effective responses must treat emotional health as part of chronic disease care rather than as a separate issue.

Chronic illness is a long term condition that changes daily lives and creates physiological pressure, often requiring ongoing medical attention. Chronic illness' may even restrict daily activities. People with physical diseases are said to have higher risks of mental disorders. Emotional well-being includes mood, stress, anxiety, self-worth, hope, and a distinct sense of control, all of which can be disrupted by chronic diseases (Golics et al., 2013). Our emotional well-being should be taken care of, as it helps us manage daily stress, build meaningful relationships, and adapt to challenges in life. Improving our emotional well-being can benefit both mental and physical health.

How Chronic Illness Affects Emotional Well-Being

Depression and anxiety often rise in people with chronic illness because it brings uncertainty, repeated treatments, and functional limits. Chronic illness' brings an additional load of stress onto said person, and if said person is already suffering from depression and anxiety, it will rise. Emotional distress is a sign that your emotional well-being is being compromised. It is intensified by the loss of independence, changes in identity, and the feeling of being "trapped" by the chronic illness that a person may have. "In people with both physical diseases and mental disorders, a lower quality of life and a shorter life expectancy have been observed than in those with either physical diseases or mental disorders alone" (Momen et al., 2024).

The Mechanisms

Physical symptoms of mental health and chronic diseases can overlap with psychological symptoms, making distress harder to notice and treat. Differentiating between psychological mental health symptoms and physical diseases can become increasingly difficult, as symptoms tend to blend together.

Chronic illness can disrupt work, family roles, routines, and social participation, which weakens emotional stability. With someone who has a chronic illness, work can be neglected, as the illness may restrict the person from working with others. Additionally, with family roles, "Compared to parents of healthy children, parents of children with chronic disease report lower self-development, restrictions on their well-being and emotional stability and lower levels of daily functioning" (Golics et al., 2013).

Financial strain and lower economic status can worsen emotional outcomes and lower health-related quality of life. Comparing your economic status with that of others can also worsen emotional-well being. Financial strain not only creates pressure on you, but the entire family as well. Quality of life is lowered in both cases. Chronic diseases can also reduce financial wellness by creating extra medical expenses, placing strain on family needs, and lowering work capacity.

Patient Resilience and Coping Strategies

The emotional effect is not identical for everyone. Some patients cope better when they have social support, routine, and a sense of meaning. Social support and a sense of meaning would help them cope and open up to others and make sure that they feel that they exist for a reason. Daily routines can help the patients maintain a constant, everyday goal. Better functioning and exercise are associated with lower anxiety and depression and higher quality of life. Exercising leads to better functioning, which keeps our bodies healthy and able to function normally. This can lead to a higher quality of life, with lower anxiety and depression.

Emotional outcomes are stronger when patients can express feelings, build acceptance, and obtain care. Receiving acceptance from family members and friends can boost the emotional outcomes that the patient feels. It is necessary for the patient to have a safe and reliable place to confide in others and express their feelings and receive care. Within patient groups, it is agreed that chronic diseases affect family life, daily activities, emotional well-being, and general finances, although the impact is determined by the exact condition. Below are two frameworks to understand the need for emotional support as part of health and disease management.

Framework 1: The Burden-to-Balance model

- Burden: symptoms, treatment demands, uncertainty.
- Disruption: identity loss, social withdrawal, role strain.
- Balance: coping strategies, support, routines, and psychological care

This helps explain emotional well-being as a moving process rather than a fixed outcome, which fits the evidence that chronic illness and distress can be a part of a moving cycle. (Golics et al., 2013)

Framework 2: The 4D emotional impact lens

Using four dimensions to analyze emotional well-being:

- Distress: anxiety, sadness, stress.
- Disconnection: isolation, stigma, reduced social contact.
- Disruption: broken routines, work limitations, family strain.
- Direction: coping, meaning-making, support, and adaptation. (Golics et al., 2013)

Prescriptions for Moving Forward on Whole Patient Care

Integrate mental health screening into chronic illness care, since depression and anxiety are common and often undertreated, or seen as unimportant. Offer combined care plans that address physical symptoms and emotional distress together, not separately, as both are more often found together in most patients. Support self-management through exercise, education, and practical coaching, because these are linked with better emotional and quality-of-life outcomes. Expand access to social support, peer groups, and family-based therapy to reduce isolation and improve coping and resilience. Address financial and job related pressures where possible, since financial strain is tied to poorer emotional well-being and quality of life.

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Women's Health: Importance of Gender in Patient Care

Alanna Craigen

Introduction

Medicine exists to relieve suffering and promote health in patients, but the quality of care patients receive depends not only on clinical advancements and technology but also on how clinicians listen, understand, and respond to the person behind the symptoms. Yet the experience of care often feels very different from that. Effective care should be patient-centered, focusing on the patient rather than the symptoms. It should incorporate empathy, clear communication, emotional support, and a whole-patient approach into accurate diagnoses and treatments. However, many patients, particularly women, do not receive care like this. Their pain is underestimated, their symptoms are misinterpreted, their warnings are brushed aside, and their conditions are diagnosed years later than men with the same diseases - leading to avoidable harm, suffering, and degraded trust in the system designed to protect their health. Good care must go beyond the clinical outcomes and to the patient behind the symptoms.

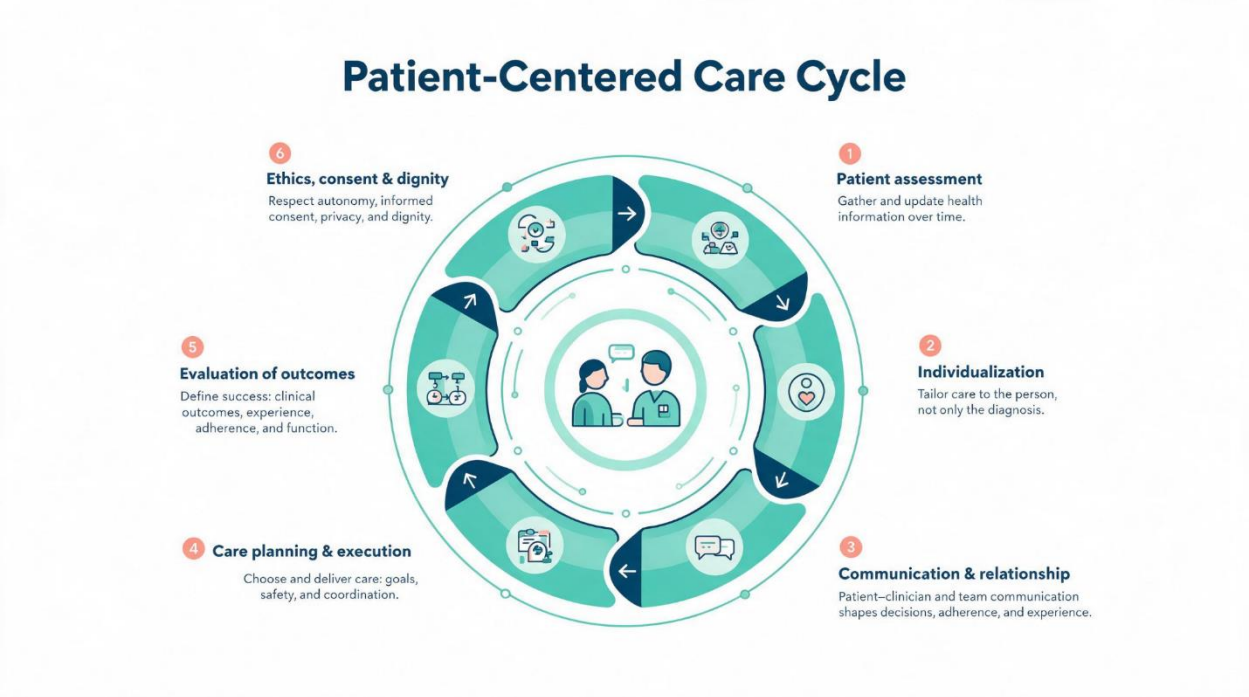
Conceptual Framework: Defining Good Patient Care

Patient centered care (PCC) is a healthcare model used to treat patients for their individual needs instead of solely the disease with collaboration from the patient and provider on a treatment plan guided by the patient's goals. PCC stems from the ideology that patients are more than their disease and someone with values, preferences, fears and lives beyond healthcare. Good care includes these premises while focusing on a balance of clinically accurate diagnosis/treatment while also respecting what matters to the patient, clear and honest communication, emotional support, coordination, and meaningful involvement in decisions [1]. When care is centered around the patient, success is now judged from health status and patients goals instead of only laboratory numbers.

A key part of this approach comes from recognizing the difference between clinical information and patient/personal information. Clinical information includes laboratory results, image findings, vital signs, medication lists, and diagnoses etc. Whereas patient/personal information encompasses the patients goals and priorities, fears and hopes, family, responsibilities, work, financial pressures, food and education access, cultural and spiritual beliefs, and past lived experiences [1]. Good care balances these two types of information as they are equally important in conversations and decisions to allow for personal information to not be ignored or dismissed.

Dimensions of Good Care

- Patient assessment (How information is gathered and updated over time)
- Individualization (Care/treatment plans tailored towards the patient not just the diagnosis)
- Communication/Relationship (Patient-Clinician + Clinician-Team) (information flow affecting decisions, adherence, and experience)
- Care planning/execution (What care is chosen and how it is carried out (Goals of care, safety steps, and coordination))
- Evaluation of outcomes (what "success" means) (Clinical endpoints, patient experience, adherence, and functional status)
- Ethics, consent, and dignity [1]



Perplexity. (2025). Perplexity AI. In *www.perplexity.ai*. https://www.perplexity.ai/

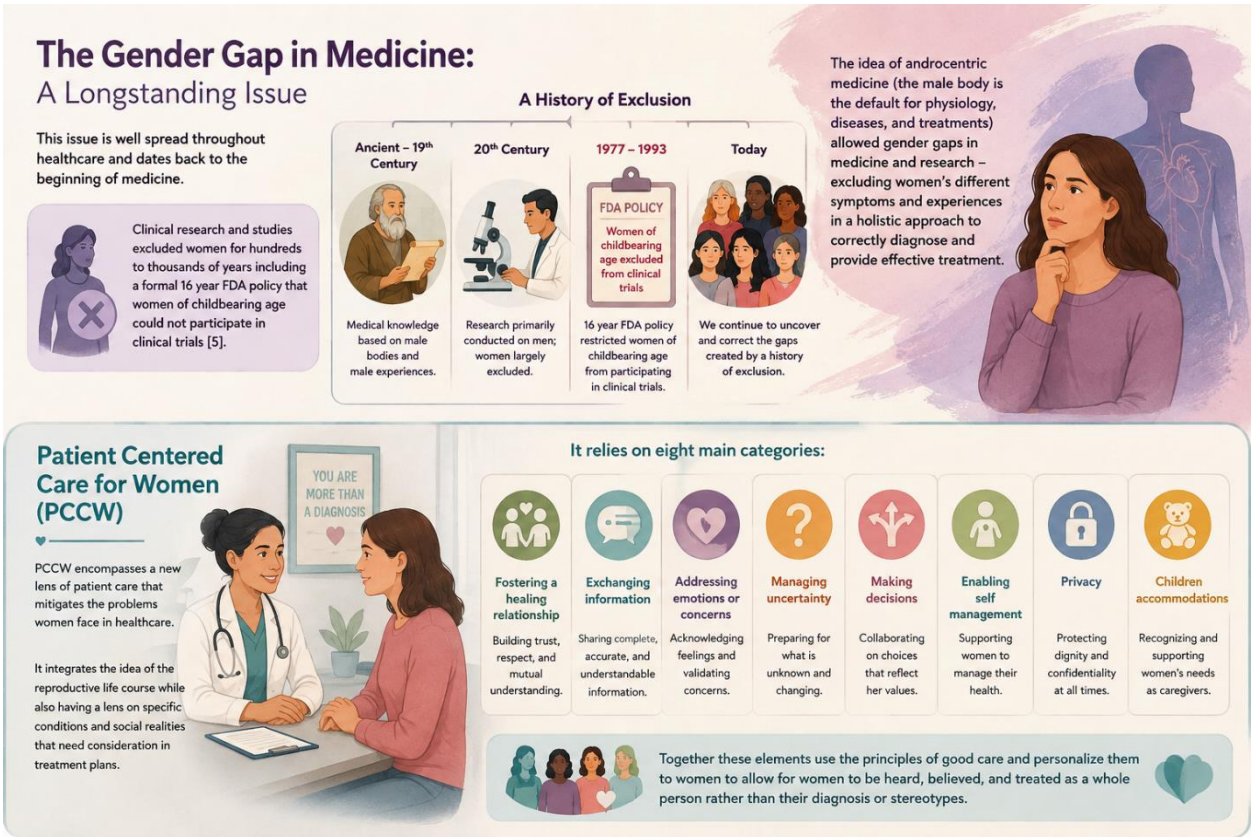
Women's Health: Importance of Gender in Patient Care

The gap between what good care should mean and what patients actually receive becomes very apparent in women's health. Women often describe their treatment as rushed, dismissed, or focused only on test results rather than their pain, fears, or daily lives. Studies show their symptoms are more likely to be normalized or psychologized as their pain is underestimated or brushed off due to hormones and menstrual cycles. Women statistically spend 25% more of their life in ill health compared to men [2] due to a multitude of causes such as delayed diagnosis. Delayed diagnosis is a major issue within women's health. A study on a family of inflammatory rheumatic diseases that cause arthritis in the spine, pelvic joints, and tendons, displayed this issue with men getting diagnosed at average 6.5 years and women getting diagnosed at 8.8 years [3]. This delay in diagnosis incorporates the incorrect PCC that women are getting when seeking care. The American Heart Association conducted research on gender difference in presentation and perception of symptoms on patients who had heart issues - with 53.4% of women reporting their provider did not believe their symptoms were heart related compared to 36.7% of men [4]. The percentage of women whose symptoms were not perceived and used in the whole patient approach correctly compared to men is significantly higher relating back to the PCC that women receive in numerous fields of medicine.

This issue is well spread throughout healthcare and dates back to the beginning of medicine. Clinical research and studies excluded women for hundreds to thousands of years including a formal 16 year FDA policy that women of childbearing age could not participate in clinical trials [5]. The idea of androcentric medicine (the male body is the default for physiology, diseases, and treatments) allowed gender gaps in medicine and research - excluding women's different symptoms and experiences in a holistic approach to correctly diagnose and provide effective treatment.

Patient centered care for women (PCCW) encompasses a new lens of patient care that mitigates the problems women face in healthcare. It integrates the idea of the reproductive life course while also having a lens on specific conditions and social realities that need consideration in treatment plans. It relies on six main categories: fostering a healing relationship, exchanging information, addressing emotions or concerns, managing uncertainty, making decisions, enabling self management, privacy, and children accommodations [6].

Together these elements use the principles of good care and personalize them to women to allow for women to be heard, believed, and treated as a whole person rather than their diagnosis or stereotypes.



OpenAI. (2025). ChatGPT. In *ChatGPT*. OpenAI. https://chatgpt.com/

Diagnosis to Treatment: Pain Management and Care Experience

Gender bias in medicine does not stop at diagnosis but continues through into the treatments patients receive particularly pain management. There is a stark difference between how regularly and the strength of pain medication is prescribed from clinicians for women and men with the same level of pain presented. There is a nine percent decrease from women with a 38% chance of getting an analgesic prescription (doctor ordered pain alleviation medication) to men with a 47% chance [7]. The bias assessment of these patients reflect a systematic disparity in treatments and continues to directly contribute to undertreatment and incomplete care of women's pain. Such disparities highlight the shortcomings of PCC and PCCW where pain reports are not equally validated. The consequences of this undertreatment are apparent across all sectors of healthcare creating broader patterns of inadequate care for women.

Heart Disease

Heart disease is the leading cause of death for women surpassing all forms of cancer and accidents [8]. Women statistically present with non-traditional symptoms of cardiac issues such as weakness or pain in the back, shoulder, or neck in addition to the traditional chest pain. A VIRGO study conducted research on women and men who were more likely to have their symptoms attributed to a non cardiac issue such as acid reflux, anxiety, muscle pain, asthma, diabetes, or fatigue. The study found that providers diagnosed 53% of women versus 37% of men from their symptoms to non cardiac issues. Multiple studies conducted from around the world added research to the shortcomings of healthcare professionals for women presenting with chest pain. Studies also show that women are more likely to be discharged from the hospital after a 2.9% admission rate compared to the male 6.6% along with another study at 33% vs 42% [9]. Women with chronic or persistent symptoms are more likely to have their complaints minimized or attributed to physiological cases which further delays appropriate evaluation. Together, these findings reflect flawed assessment, misinterpretation of clinical information, and failure to fully listen to women's symptoms.

Reframing "Good Care" through Women's Stories

One useful next step is to put women's patient stories through the six dimensions of patient care (assessment, individualization, communication, planning, evaluation of outcomes, ethics/dignity) to help show where care falls short even when outcomes look good [1]. Instead of clinicians relying on scores or checklists they can read patient stories such as the 10,000 voices programme where symptoms are minimized, preferences are ignored, explanations are unclear, or dignity compromised [10]. Patterns often emerge once looking at multiple patient experiences which brings a new light on how to address patients and match the level of care to the expectations such as feeling heard, respected, and safe not just test results and procedures going to plan.

Redefining Patient Success in Patient Care

Success in patient care should be defined as more than a cure or normal test results. It should also include timely and accurate diagnosis, relief of suffering, feeling heard and respected, and care that aligns with women's goals, values, and lived experiences. Clinical outcomes such as survival, lab values, or procedural success are important but are only half of the story and outcome [11]. They do not encompass whether the patient truly feels themselves or if the care was meaningful and impactful to them and their quality of life.

Measurement and evaluation in women's healthcare should encompass clinical indicators with patient recorded outcomes and experiences to measure both technical quality and lived experience. Additionally tracking survival, lab values, or treatment response healthcare systems should include diagnostic delay, misdiagnosis, and whether patients felt dismissed, believed, heard, or overlooked [11]. Encompassing all of these patient centered care key features it will create a more rounded and complete assessment of care and whether it was effective and patient centered.

Implications for Practice, Education, and Policy

Improving gender inclusive care requires intentional changes in clinical practice. Clinicians should receive training on gender bias and solutions to mitigate such bias. Clinicians should also ask their patients questions such as "*what matters most to you today*"- while assessing their patients and as they create goals for the prescribed treatment plan when considering clinical test results, symptoms, and personal context. A patient centered lens when giving care is the most important to encompass all parts of the patient for better care. Studies show training medical students to center their care lens on pain as a complex and gendered issue, improves their application of their communication, emotional evaluation, and social skills [12]. Greater awareness of known diagnostic delay patterns in women's health is crucial when symptoms are subtle, atypical, or overlooked.

Meaningful progress also requires systemic level change. Healthcare systems should identify the gaps in care between men and women and track these differences through data that can guide interventions within the system. Clinical guidelines should be revised to better reflect women's health presentations and the existing research on gender based differences. In addition, patient stories and experiences with women's health struggles should be highlighted to bring greater attention to the concerns. These measures would help reveal the gaps in care and increase the accountability for reducing them [13].

Ultimately, gender inclusive care should be viewed as an ethical responsibility and a matter of justice rather than a quality improvement issue. When women's concerns are minimized, overlooked, or delayed, the consequences extend farther than patient dissatisfaction and to preventable harm and structural inequality [14].

Conclusion

In conclusion, good patient care must be patient centered, gender aware, and grounded in genuine listening and respect. Care should not only be judged by clinical accuracy or technical outcomes, but also by whether patients feel heard, understood, and meaningfully involved in decisions about their health. Current evidence shows that women continue to experience diagnostic delays, misinterpretation of symptoms, and undertreatment - demonstrating that healthcare remains far from the standard of good care as defined in this paper. These patterns reflect ongoing structural and gender based inequalities rather than isolated mistakes. Moving forward, care must be redesigned around patients, especially around women's health realities instead of being shaped by historic male centric models [4,6,15].

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Hidden Loops in Cancer: Persistent Homology Framework for PDAC Transcriptional State Discovery

Siqi Tan

Introduction

Pancreatic ductal adenocarcinoma (PDAC), the most common form of pancreatic cancer, arises from the ductal cells responsible for transporting digestive enzymes (Chandana et al., 2024). PDAC tumors frequently develop resistance to gemcitabine, a standard first-line chemotherapy, through mechanisms that remain incompletely understood (NCCN, 2024). This project approached the problem from a different perspective: by examining the shape of the data itself. This approach revealed a hidden loop of tumor cells cycling through a stress-adapted state, one linked to chemotherapy resistance.

The Blind Spot

Single-cell RNA sequencing (scRNA-seq) is the leading way to profile gene activity across thousands of individual tumor cells (Jovic et al., 2022). These cells are typically analyzed by grouping them into clusters or arranging them along trajectories to infer cellular change. However, both approaches assume that cellular states follow discrete groups or branching paths. Neither can naturally capture a closed loop, where cells transition through a repeating sequence of states and return to an earlier state. If pancreatic tumor cells exhibit such behavior, it may go unseen by conventional methods as they are mathematically structured to represent clusters and branching trajectories, not cycles (Rizvi et al., 2017). It is also important to note that several tools have been developed to detect cyclic patterns in single-cell data, but many rely on deep learning architectures that function as black boxes, offering limited interpretability into how their structures are derived (Wagle et. al. 2024). Thus, this study aims to investigate a fully transparent, mathematically grounded pipeline.

Reading Shape Instead of Groups

This project applied persistent homology, a method from mathematics that analyzes the shape of data. Rather than grouping or ordering cells, it asks: what shape does the entire dataset form? A loop is a closed structure in which connected points circle back on themselves, enclosing an empty region. Its persistence, or how consistently it remains across different data scales, helps distinguish meaningful biological structure from noise (Edelsbrunner & Harer, 2010). The method was applied to 10,699 pancreatic ductal cells from 20 PDAC patients (Steele & Pasca di Magliano, 2020).

What the Analysis Revealed

Through the analysis, one loop stood out. Its persistence score was 2.457, substantially higher than the next strongest structure at 1.918. To test whether this reflected noise, the dataset was randomly shuffled 500 times. The loop scored higher than 96% of randomized datasets ($p = 0.038$), better than the standard 0.05 threshold. The loop was also biologically distinct: all 158 cells came from tumor tissue, with none from adjacent healthy tissue. As shown in Figure 3, standard clustering had grouped these cells with over 7,000 others, concealing the subpopulation. Topological analysis therefore resolved a population roughly 46 times more specifically than clustering alone. The unchanged pipeline was then tested on two independent PDAC cohorts (Hwang et al., 2022; Chen, 2022), where comparable loops emerged with persistence scores of 2.218 and 2.343.

A Transition Between Cell States

Each of the 158 loop cells was assigned a position along the ring. As shown in figure 4, plotting gene activity against this position revealed a clear pattern: the cells did not behave randomly, but progressed through two distinct phases. In the first, gene activity remained relatively low. Then, many genes shifted from low to high activity simultaneously, marking a transition into a more active state. Such coordinated changes are unlikely to occur by chance, suggesting that a shared biological signal may be driving this transition. Pathway enrichment analysis identifies biological processes shared by a group of genes. The loop cells showed signs of low oxygen and changes in how they use sugar for energy, as well as changes in how they attach to and move through surrounding tissue. Their genes also suggested cellular stress and damage from harmful molecules. Together, these patterns suggest that the loop captures tumor cells adapting to survive in a harsh environment.

Genes of Interest

Using a mathematical analysis, the genes that changed most closely with the cells' position along the loop were singled out. One notable example was GABRP. Previous research has shown that GABRP promotes gemcitabine resistance in PDAC and that patients with lower GABRP expression have longer survival (Chen et al., 2022). However, in this study, GABRP expression in the loop increased specifically during the loop's second, more active phase, suggesting that GABRP chemotherapy resistance may be a dynamic cell state rather than a constant trait. NQO1 showed a similar pattern. It helps cells defend against oxidative stress, which occurs when reactive oxygen molecules accumulate and can contribute to chemotherapy-induced damage (Srijiwangsa & Na-Bangchang, 2017). CEACAM6, a surface protein linked to suppressing T-cell activity, also peaked in this phase, helping tumors evade immune attack (Pinkert et al., 2022). Together, these three genes suggest that mechanisms of drug resistance, stress protection, and immune evasion may emerge together in this recurring tumor-cell state.

Targeting a Window of Vulnerability

If resistance genes activate only during one recurring phase of the loop rather than staying on permanently, then timing treatment to that phase, rather than searching for an entirely new drug, becomes a plausible strategy. 54 genes were found to be cycling within the loop, and were checked against a drug interaction database (Cannon et al., 2024), identifying 135 FDA-approved drugs targeting 28 of them.

Limitations

scRNA-seq provides a snapshot of each cell at a single point in time. It cannot demonstrate that individual cells physically move through the loop, only that the data's geometry is consistent with a cyclic state transition. These findings are also correlative, not mechanistic. Establishing whether the loop directly contributes to resistance during the active phase would require experimental perturbation, such as gene knockout, followed by testing chemotherapy response across different stages of the cycle.

Conclusion

By examining data geometry, this project uncovered a closed loop of tumor cells unseen by conventional methods. Resistance- and immune-related genes changed along the loop, suggesting these traits may create windows of vulnerability that existing drugs could target. More broadly, this work aims to establish an accessible, reusable framework for uncovering hidden loops in cancer data. Hopefully, this is not just a nuanced way of analysing PDAC, but a step toward understanding resistance, better treatment strategies, and improving patient outcomes.

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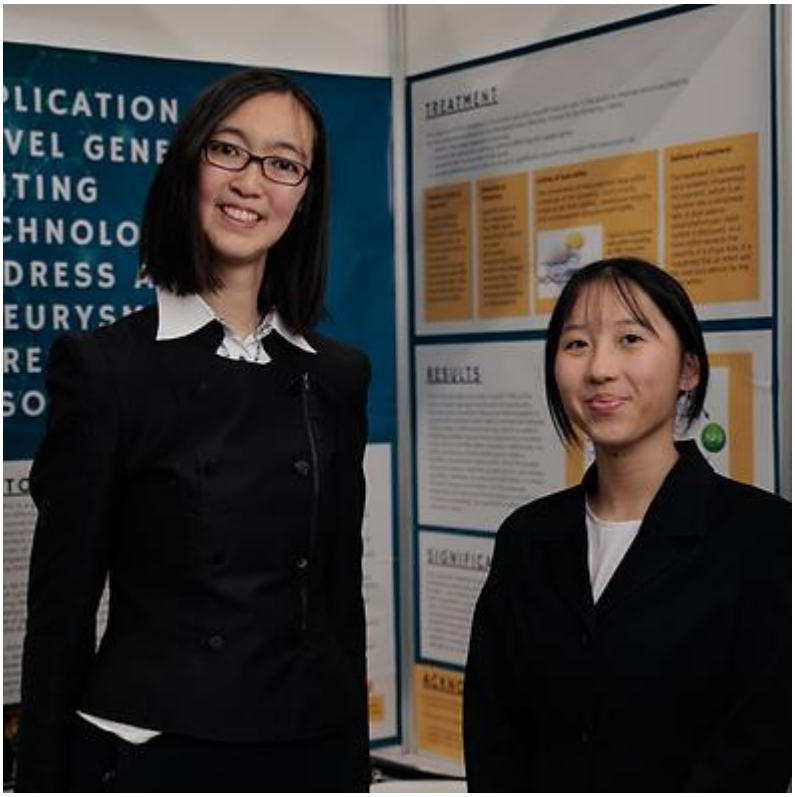
Turning a Lived Health Journey into Outstanding Science: Journey into Science Fairs

Judy Wang and Isabell Zhang



As Editors at BioEndeavor, we were so inspired by this project and learning how one team member's health journey inspired this outstanding CWSF project, we want to share Judy and Isabell's story to empower other students, teachers, and parents. Science fairs are about celebrating innovation as well as creating impact for our communities and societies through STEM. These stories should be broadly shared as we strive to bring purpose to STEM. Thank you Judy and Isabell for sharing your touching story.

The Inspiration

Marfan syndrome (MFS), a connective tissue disorder caused by FBN1 gene mutations, affects 1 in 5000 individuals. Current interventions for MFS are insufficient; they only mitigate symptoms and must be continuously maintained. Judy herself was born with a de novo case of MFS, and has always felt an inexplicable curiosity toward its causes. She enjoys pondering solutions to this disorder using modern medical innovations. Isabell has a deep fascination for bioengineering and genetic editing and a penchant for research. We decided to collaborate on this project because we are close friends and feel that we complement each other's strengths; Isabell is a diligent, efficient researcher and Judy is a passionate scientific communicator.

The Innovation

In this project, July and Isabell synthesized scientific research to identify technologies for eliminating the severest MFS symptom: aortic aneurysm and dissection. We propose a novel genetic modification tool, base editing, for repairing aortic cells by changing individual letters in the genetic code to correct missense mutations (the leading cause of MFS). To conduct the following research, predominantly qualitative scientific evidence was synthesized.

Of the 112 sources reviewed from platforms such as PubMed and ScienceDirect, 64 were cited, with criteria including relevancy, credibility of authors, corroboration with other sources, and recency (ideally published within the decade). We specifically focused on the potential effectiveness of base editors in minimizing the effects of Marfan syndrome by editing aortic

smooth muscle cells to correct the FBN1 gene, resulting in a healthier extracellular matrix and overall more resilient aorta. Base editors have rescued mouse models with similar aortic dilation and restored MFS stem cells to normal morphology and karyotype. This treatment should ideally be administered pediatrically, leveraging next-generation sequencing panels to identify the mutations' loci, utilizing Sanger sequencing to confirm results for quality control, and using adeno-associated virus 9 as the vector for intravenous injection.

The foremost challenge will be to attain the critical mass of edited cells to create a positive feedback loop, significantly improving cellular environment regulation and patient outcomes. Since existing methods to manage MFS often involve years (if not a lifetime) of avoiding strenuous physical activity, medication, and potentially invasive surgery, this treatment shows promise in providing a more proactive and permanent way to reduce the impact of symptoms. This potentially increases life expectancy and quality for an estimated 1.6 million MFS patients worldwide. To clinically implement this treatment, further research is needed to facilitate functional base editors. This process will use online models to simulate FBN1 gene mutations using DNA libraries and assess the ability of various base editor iterations to correct missense mutations to restore the unaffected phenotype. Next, animal model preclinical trials can be used to determine the effectiveness of the treatment in whole organisms. The treatment must follow all legal frameworks and be approved for clinical trials before it can be implemented. In the future, a similar theory can be applied to zonule cells to minimize ectopia lentils in MFS patients.

Canada-Wide Science Fair Experience

We genuinely found the Canada-Wide Science Fair to be the most challenging week of our lives, and also the most rewarding week. Since the moment we boarded the airplane bound for Edmonton wearing our bright scarlet Team BASEF jackets, we knew we were about to have the time of our lives. From practicing our presentations with peers late at night to strategizing answers for judges' potential questions even later at night, we were surely hard at work. From witnessing a revolutionary senior care robot prototype to hearing a riveting presentation about a novel antifungal medication, we were indubitably inspired. From meeting healthcare professionals with PhDs to debating bioethics with Team Canada Science Fair members, we definitely did a lot of networking. From touring the huge Edmonton Mall to attempting break dancing during the farewell party, we unquestionably had fun. Most importantly, we formed deep bonds with truly unforgettable people. From yelling musical theatre songs to trading virtual Pokémon cards, we certainly made friends to last a lifetime. CWSF left us with many cherished memories and ultimately inspired us to dream bigger, work harder, and fall in love with science more.

Future Aspirations

Isabell aspires to work in the healthcare field after university to merge her intellectual curiosity for the biomedical sciences with real-world applications to help patients, especially by leveraging her experience with bioengineering and psychology. Judy aims to become a pediatrician because she believes that a child's trust is precious, and their smile after feeling better is even more so; she also intends to educate youth about health as a proactive prevention by using her skills as an engaging presenter.

Reading Minds: Brain-Computer Interfaces and How They Change the Future

Aditri Amresh

By all accounts, Ann Johnson was an ordinary 30-year-old woman. She was the math teacher and volleyball coach at a high school in Saskatchewan, spending her mornings at a whiteboard, and her evenings hyping up her students for the big game. A year earlier, she'd had a baby girl with her new husband. She was a pillar of her Saskatchewan town, someone who always found a way to inspire her students and bring a smile to people's faces.

Yet one summer day, while playing volleyball with her friends, Johnson experienced a rare brainstem stroke, leaving her with locked-in syndrome, a rare neurological disorder in which a person is fully conscious and aware of their surroundings but completely paralyzed. She could see, hear, and feel, but could not communicate. She could no longer tell her family how much she loved them. She could no longer hug her baby girl or explain math and volleyball to an eager class. She was alive but couldn't do what made her feel human. She spent 18 years in this condition until she signed up for a clinical trial with UC Berkeley in 2022, where a team of researchers came up with a solution to help her speak, even without control of the muscles involved in speech: they used a brain-computer interface (BCI). (Brice & Manke, 2025.)

But what is a BCI, anyway? How can this cutting-edge technology change the lives and outcomes of stroke victims and people with ALS? And, perhaps the most important question of all, does this technology have a dark side?

What Are BCIs?

A brain-computer interface or BCI, is a link between the human brain and an external device, usually a computer or a prosthetic. Functional BCIs have a history dating back to the 1980s, when scientists used an EEG to read human brainwaves and send those signals to a buzzer that made a sound whenever a participant thought about pressing it. While even that may seem like science fiction, today, BCIs have advanced much further, with some recent models seemingly able to "read minds." (Bozinovski & Bozinovska, 2019)

Ann Johnson's case is a striking example, which raises the question: How exactly did scientists enable her to speak?

Before the BCI, to communicate, Johnson used a system called a matrix speller, similar to the computerized voice system that Stephen Hawking used to speak after his ALS grew severe. Yet, instead of twitching a muscle in her cheek to select letters, the matrix speller flashed letters in front of Johnson one by one on a computer screen and tracked when her eye movements indicated that she wanted to select a particular letter. This could be a very slow method of communication, averaging about 14 words per minute, and it didn't have a "voice," meaning she could only communicate by "typing" words at a very slow rate. She lived life like this for 18 years, until she was selected for a clinical trial by UC Berkeley that claimed to do what was thought impossible: help Johnson speak again.

The process involved surgically implanting a paper-thin grid containing 253 electrodes into Johnson's speech motor cortex, or the part of her brain that coordinates the movements of the tongue and jaw - parts of her body that were still paralyzed. These electrodes captured and interpreted the electrical signals that came from Johnson's brain whenever she tried to say something but couldn't actually say it. For example, Johnson would type the word "dog" on her matrix speller and then attempt to say the word "dog." The electrodes recorded the neural patterns that fired when she attempted to say the syllables of the word "dog," and scientists then plugged the data into an AI algorithm that associated the firing of those pathways with the word "dog."

Using this data, scientists trained the AI algorithm to eventually predict which neural signals corresponded to which words, allowing it to predict what Johnson was saying with 75% accuracy. But what they did next was analyze a video of Johnson - specifically, a video from her wedding - to get a picture of what her voice sounded like. They then created a customized AI avatar that took Johnson's attempted speech and spoke in Johnson's voice, with the avatar's facial movements corresponding to spoken words. Now, when Johnson even attempted to say the word "dog," the system could decode that neural signal and the AI avatar would say the word "dog." Ultimately, she could speak in her own voice using the avatar, at an astounding rate of nearly 80 words per minute. (University of California, 2023)

"Hearing my voice is like hearing an old friend again," she said. "This study gave me a sense of purpose and helped me live while I'm alive." She is now a disability advocate, using her story to give a sense of hope to others who have faced accidents. "It's like a dream come true." (Mannie, 2023)

Implications

While Johnson's story is truly inspiring, the development of BCIs raises the question of mental privacy. If a system can be trained to "know what we think," what keeps our thoughts private? And can this compromise our mental autonomy? (Ienca & Adorno, 2017)

To address the first question, current BCIs can only decode neural signals that correspond to intended movements, speech, or other specific tasks. They can tell when someone wants to move their arm, move a cursor, or speak a word, but right now, they cannot decode unrestricted thoughts, read unexpressed emotions, or interpret a general stream of consciousness. (Stanford University, 2025) While future BCIs may have such capabilities, it is not a current research question and would require years of studies.

However, what a BCI can do is measure focus, using a device called an EEG (electroencephalogram), a non-invasive device that does not require a surgical implant. Changes in EEG activity across different frequencies can be associated with different mental states like attention, relaxation, and productivity. A 2025 study by the University of Alba Iulia used wearable EEGs to track students' focus levels while playing different video games and discovered that EEGs could accurately convey the attention levels of students to a computer. This direct transmission of neural activity to a device has several potential implications. An interpretation of this study concludes that this EEG method could potentially allow technology companies to develop a user interface that monopolizes attention, potentially making social media and gaming sites even more addictive. (Kadar, 2025)

Furthermore, now that mental focus levels can be measured using just a wearable device, this could be used to track attention levels in schools and workplaces, which is a serious mental privacy concern. Should an employer be able to check how focused you are by reading signals directly from your brain? AI tracking systems are already measuring worker productivity in unethical ways, but this could take things one step further, with potentially serious consequences for the workforce.

Patient stories highlight the side of BCIs that can be used to heal and restore, but as BCI capabilities grow more and more advanced, they also have the potential to be used maliciously. Historian and author Yuval Harari, says, "While neurotechnologies and brain-computer interfaces can be used for great good- such as healing neurological disorders -they also possess the unprecedented power to… severely threaten mental privacy and cognitive liberty." (Harari, 2026)

While BCIs cannot read thoughts yet, they can measure several other factors, and while that is undoubtedly a win for research, it may be a loss for human privacy.

Conclusion

As the debate surrounding BCIs rages on, Johnson continues to live her life like an ordinary 48-year-old woman - with an extraordinary story. While she hasn't taught in years, she dreams of becoming a trauma counselor. "I want patients there to see me and know their lives are not over now," she says. "I want to show them that disabilities don't need to stop us or slow us down." She thanks the team at UC Berkeley and BCI technology for giving her life back. (Mannie, 2023)

While BCIs have the potential to be used for harm, right now, stories of various ALS patients who use BCIs to communicate, inspire others and showcase how, as of right now, this cutting-edge technology is working overtime as a force for good. If taken into the wrong hands, the ability to decode neural signals could create a dystopia, ruining mental autonomy for millions. But right now, as Ann Johnson lives another day feeling like her old self again, I am urged to be an optimist- to look at BCIs' beautiful present instead of their menacing future.

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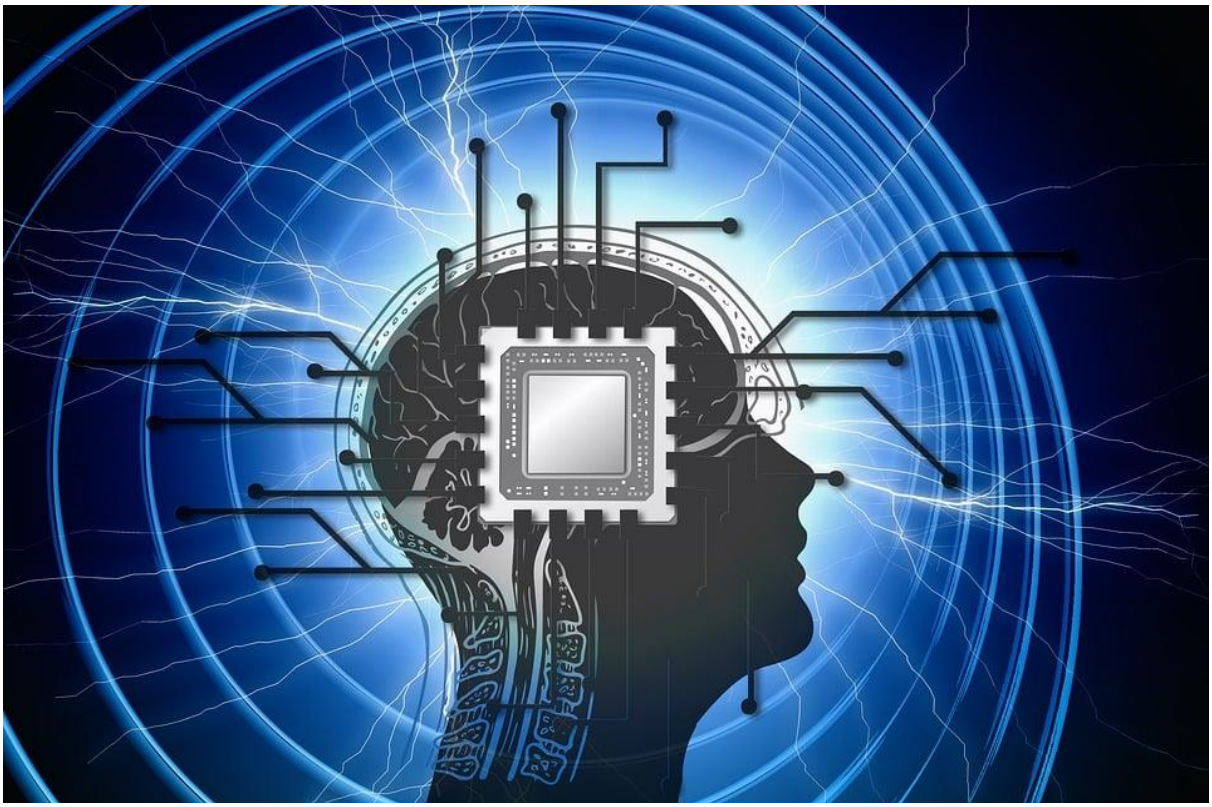

Predicting Childhood Asthma Risk from Local Air Quality in Orange County, Florida: A Data-Driven Analysis of PM2.5, NO_2, and Ozone Exposure

Shanmathi Rajendran

Abstract

Asthma is one of the most common chronic respiratory diseases among children and is influenced by both genetic and environmental factors. (Miriam Anand, 2024) Air quality is determined by pollutants such as particulate matter (PM2.5), nitrogen dioxide (NO_2), and ozone (O_3) levels. These pollutants have been associated with airway inflammation and respiratory complications. This study investigates whether yearly changes in air pollutant concentrations correlate with childhood asthma emergency department (ED) visit rates in Orange County, Florida. Air quality data from the Orange County 2024 Air Monitor Site, FDEP was used. PM2.5, NO_2, and Ozone were analyzed alongside asthma ED visit rates among individuals aged 0–17 years from 2018–2024. (Florida Department, 2026; Orange County, 2024). Pearson correlation analysis was performed to identify relationships between pollutant levels and asthma outcomes. Results showed that NO_2 had the strongest positive association with childhood asthma ED visits ($r \approx 0.73$), while PM2.5 showed a weaker positive relationship ($r \approx 0.33$). Ozone demonstrated a negative correlation ($r \approx -0.88$), although this relationship may be influenced by confounding factors and the limited dataset size. These findings suggest that NO_2 may be a stronger predictor of childhood asthma risk in Orange County compared with annual average PM2.5 and ozone concentrations.

Introduction

Asthma affects millions of children worldwide and is characterized by chronic inflammation and narrowing of the airways. Although asthma has genetic components, environmental exposures can contribute to asthma development and its exacerbation. Air pollution is considered one of the major environmental risk factors because pollutants can trigger airway inflammation and increase risk of any respiratory illness. (Miriam, 2024)

Three important air pollutants associated with respiratory health are fine particulate matter (PM2.5), nitrogen dioxide (NO_2), and ground-level ozone (O_3). PM2.5 is made up of extremely small particles that are able to travel deep into the lungs where they can irritate the airways and worsen asthma symptoms. (Miriam, 2024) NO_2 is produced by vehicle emissions and combustion processes and can irritate respiratory pathways. (EPA, 2016) Ozone is a secondary pollutant formed through chemical reactions involving both sunlight and nitrogen oxides. (Miriam, 2024)

Orange County is one of Florida's fastest-growing urban regions, with heavy vehicle traffic and rapid development. Increase in urbanization, potentially increasing exposure to traffic-related pollutants. (Janyae, 2026) This study examines whether changes in air quality are associated with childhood asthma emergency department visits.

Research Question
How do annual concentrations of PM2.5, NO_2, and O_3 correlate with childhood asthma emergency department visit rates among individuals aged 0–17 in Orange County, Florida?

Hypothesis
It was hypothesized that increasing annual concentrations of PM2.5 and NO_2 would be positively associated with childhood asthma emergency department visit rates because both pollutants are known to promote airway inflammation. Ozone was also expected to show a positive association, although its effects may vary depending on meteorological conditions.

Methods

Data Collection
Asthma emergency department visit data for individuals aged 0–17 years were obtained for Orange County, Florida. The outcome variable used was the asthma ED visit rate per 100,000 children. (FL Health Charts, 2026)

Air quality measurements were collected from Florida air monitoring records.
PM2.5 ($\mu g/m^3$), Nitrogen dioxide (NO_2), and Ozone (O_3) were measured.
The years analyzed included 2018, 2019, 2022, 2023, and 2024.

The final dataset was used from FL Health Charts, Emergency Department Visits From Asthma (Aged 0-17). It consisted of five yearly observations.

Data Analysis
Annual pollutant averages were compared with asthma ED visit rates. Pearson correlation coefficients were calculated to determine the severity of the relationship.
A correlation coefficient closer to +1 indicates a positive relationship, while values closer to −1 indicate a negative relationship.

Results

Air Quality and Asthma Dataset

Year	*Asthma ED Rate*	*PM2.5*	*NO_2*	*O_3*
2018	1096.1	6.106	10.59	32.40
2019	938.1	6.196	9.94	34.13
2022	769.8	6.690	9.59	37.23
2023	814.1	7.328	7.36	39.07
2024	671.5	5.840	8.06	37.95

NO_2 demonstrated the strongest relationship with asthma in adolescents ED visits.
The correlation coefficient between NO_2 and asthma ED rates was approximately **r = +0.73**
This suggests that years with higher NO_2 concentrations generally had higher childhood asthma emergency visits. In 2018, NO_2 was highest (10.59 PPB – Parts Per Billion) and asthma ED visits were highest (1,096.1 per 100,000). Also, in 2024, NO_2 decreased to 8.06 PPB and asthma ED visits decreased to 671.5 per 100,000.
PM2.5 showed a weaker positive relationship: **r = +0.33**
Although PM2.5 is known to affect respiratory health, yearly averages did not strongly predict asthma ED visits in this dataset. One possible explanation is that asthma attacks may be influenced more by short-term pollution spikes rather than yearly average.

Interestingly, Ozone showed a negative relationship: **$r = -0.88$**

This finding should be interpreted cautiously. Although Ozone exposure is associated with respiratory irritation, this dataset showed increasing Ozone levels while asthma ED rates declined. This could have been because of limited sample size, changes in healthcare access, COVID-19 impacts, exposure differences, or other environmental factors.

The strong positive association observed between annual NO2 levels and pediatric asthma ED visit rates is worth noting. Numerous studies examining urban air quality have demonstrated that NO2 pollutants show vehicle emissions leading to airway inflammation in 0-17 aged populations. Similar studies also show yearly increases show short-term pollution spikes that drive emergency department visits.

Discussion

The results indicate that NO_2 may be the strongest predictor of childhood asthma emergency visits in Orange County, Florida. This finding supports previous research showing that traffic-related pollution can contribute to respiratory inflammation and asthma to exacerbate. The weaker PM2.5 correlation may be due to the use of annual averages. Children may experience asthma symptoms after short-term exposure events, such as when pollution tends to peak/spike, which yearly averages may not capture.

The Ozone relationship highlights the importance of considering additional variables. Ozone depends on temperature, sunlight, and interactions with other pollutants. Therefore, annual Ozone averages may not accurately represent harmful exposure periods. To evaluate childhood asthma risk accurately, the outcome metric was restricted to ED - emergency department visits diagnosed for asthma among children aged 0-17 (this data was found from Florida Health Charts).

Limitations

There was various limitations in this study due to the fact it heavily relied on past data in Orange County, Florida. Finding specific data was a tedious task - several limitations included a small sample size since there was only 5 years of matched pollutant and asthma data available. Annual averages were used and short term pollution events were not prioritized. Confounding variables such as pollen, weather, socioeconomic conditions, access to healthcare, and COVID-19 had the probability to influence asthma rates. Population levels also pose a risk in contributing to respiratory illness in children.

Conclusion

This study investigated the relationship between PM2.5, NO_2, Ozone, and childhood asthma emergency department visits in Orange County, Florida. Among the pollutants analyzed, NO_2 demonstrated the strongest positive association with asthma ED rates, suggesting that primarily vehicle driven air pollution may play an important role in childhood respiratory health. While PM2.5 showed a weaker relationship, Ozone results were inconsistent and required further investigation. This can be improved if the data set could be expanded with additional years to provide an improved and stronger prediction of impact of pollutant. Overall, this research suggests the need to develop a stronger understanding of environmental factors affecting childhood asthma risk.

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The Hidden Gap: Why Cardiovascular Health Knowledge Remains Less Accessible to Women

Alyssa Riojas

Introduction: Heart disease is the leading cause of death for women in the United States, yet most women don't know it. In 2019, only 44% of women understood that heart disease was their number one killer, and that awareness has actually been declining since 2009 (Wenger et al., 2022). This is not a coincidence. It's the result of decades of research, diagnostic tools, and medical training built around male physiology, leaving women with less information about a disease that kills more of women than any other. Cardiovascular health knowledge remains less accessible to women than to men because research, diagnostic criteria, and medical training have historically centered on male bodies, and that gap has real consequences for who gets diagnosed in time and who doesn't.

Historical Background: The roots of this problem go back further than most people realize. Before 1993, women were routinely excluded from clinical trials, including cardiovascular studies, largely because researchers worried that hormonal fluctuations would complicate their data and that including women raised recruitment costs (Berlin & Ellenberg, 2009). That changed with the NIH Revitalization Act of 1993, which for the first time legally mandated the inclusion of women and minorities in NIH-funded research, following the discovery that a major study on aspirin and heart attack prevention had been conducted entirely on men (Brigham and Women's Hospital, n.d.). But even after 1993, there was little to no progress. Cardiovascular trials that included both sexes saw female participation rise from just 18% in 1970 to only 34% by 2006 (Berlin & Ellenberg, 2009). The decades of male-only data collected before that shift helped cement a cultural narrative that heart disease was primarily a "man's disease," an idea that still shapes how symptoms get talked about today. Diagnostic tools weren't spared either. The Framingham Risk Score, which has been the gold standard for estimating cardiovascular risk for over 50 years, was built on data that didn't account for the anatomical differences between male and female hearts, like the fact that women's hearts are smaller and have thinner walls (St. Pierre et al., 2024).

The Knowledge Gap at the Public Level: One of the clearest places this shows up is in how symptoms get recognized, both by patients and by the public health campaigns meant to inform them. Women having a heart attack often experience symptoms like extreme fatigue, jaw or back pain, nausea, and shortness of breath rather than the classic chest-clutching pain most people associate with cardiac events, and some cardiologists now avoid the term "atypical" altogether in favor of "less recognized," since the symptoms aren't actually rare for women, just underdiscussed (American Heart Association, n.d.). But public health messaging has historically emphasized the male-typical presentation, meaning women are less equipped to recognize their own symptoms when they happen. Dr. Véronique Roger, a co-author of the AHA's 2022 presidential advisory, put it bluntly: comparing women's symptoms to men's data implicitly treats male presentation as the "right way," which frames women's atypical

symptoms as a deviation rather than a normal variation (Wenger et al., 2022). The consequence is delayed self-recognition. If you don't know your symptoms count, you don't seek help in time.

The Knowledge Gap at the Clinical Level: This gap doesn't stop with patients. It extends directly into how doctors are trained and how conditions get diagnosed. A 2024 study using UK Biobank data and machine learning models found that for conditions with non-sex-specific diagnostic criteria, like first-degree atrioventricular block and dilated cardiomyopathy, women are underdiagnosed at rates 2 times and 1.4 times higher than men, respectively (St. Pierre et al., 2024). That's not a small margin. It means the same diagnostic thresholds that work reasonably well for men are actively failing women.

Provider training compounds the problem. According to the AHA's advisory, nearly 7 out of 10 post-graduate medical trainees reported receiving little to no training on gender-based medical concepts. Only 22% of physicians and 42% of cardiologists said they felt prepared to adequately assess heart disease specific to women (Wenger et al., 2022). Conditions that disproportionately affect women, like MINOCA (myocardial infarction with non-obstructive coronary arteries) and SCAD (spontaneous coronary artery dissection), remain understudied compared to more "traditional" presentations of heart disease (El Bassiri et al., 2025). If the people diagnosing heart disease aren't trained to recognize how it shows up in women, the gap in public knowledge becomes a gap in clinical outcomes too.

Structural and Systemic Causes: Underneath all of this is a research funding and participation problem. A 2020 review of cardiovascular trials conducted between 2010 and 2017 found that women made up only about 27% of participants in coronary artery disease studies (Corliss, 2022). When the foundational research skews this heavily toward one sex, every downstream guideline, drug dosage, and diagnostic criterion inherits that same bias. This same underrepresentation shows up across heart failure, coronary disease, myocardial infarction, and arrhythmia trials, where women report barriers to participation including lack of information about the research, concerns about trial procedures, and practical constraints like childcare and travel (Matthews et al., 2024), further narrowing the pool of people whose data actually shapes treatment guidelines.

These gaps don't affect all women equally. A systematic review published in npj Women's Health found that cardiovascular disease remains especially underdiagnosed and undertreated among older women, low-income populations, and ethnic minorities, and that progress in reducing cardiovascular mortality among women overall has stagnated as a result (Wang et al., 2024). Race, income, and insurance access all layer on top of the baseline sex-based gap, meaning the knowledge and care disparity is even wider for some women than others.

Consequences: The result of all these compounding gaps is measurable in outcomes, not just awareness. Women are less likely to receive diagnostic imaging, percutaneous coronary intervention, and statin therapy even when they present with clinical indicators comparable to men's. Women having ST-elevation myocardial infarctions also face higher rates of bleeding complications and 30-day mortality, and conditions like MINOCA (myocardial infarction with non-obstructive coronary arteries) and SCAD (spontaneous coronary artery dissection), both more common in women, remain comparatively understudied (El Bassiri et al., 2025). These aren't abstract statistics. They represent real delays in treatment, missed diagnoses, and preventable deaths that trace directly back to a knowledge system that was never built with women in mind from the start.

What's Changing: The good news is that this gap has been increasingly documented, and that documentation is starting to drive change. The AHA's 2022 presidential advisory explicitly calls for more research studies focused on women, especially women from diverse racial and ethnic backgrounds and at younger ages, along with better data collection to inform care (Wenger et al., 2022). On the technology side, researchers are using machine learning to build more sex-specific diagnostic models. The UK Biobank study mentioned earlier didn't just identify the underdiagnosis problem, it also demonstrated that models incorporating sex-specific criteria could meaningfully improve detection accuracy for both men and women (St. Pierre et al., 2024). Public awareness campaigns have also worked to shift the cultural narrative. The American Heart Association's Go Red for Women campaign, launched in 2004, was created specifically to increase awareness and close gaps in cardiovascular care for women, and over the past two decades it has helped expand research funding and enhance public knowledge (American Heart Association Journals, n.d.). Even so, the advisory notes that awareness gains made in the 2000s have since slipped, showing that this kind of progress isn't guaranteed to stick without sustained effort (Wenger et al., 2022).

Conclusion: Cardiovascular health knowledge didn't become less accessible to women by accident. It's the product of a research and medical education system that, for most of its history, treated male physiology as the default and women's experience as a variation to be explained later, if at all. That legacy still shows up today in diagnostic criteria that underdiagnose women, in provider training that leaves most doctors unprepared to recognize how heart disease looks in a female patient, and in public awareness that has actually gotten worse over the last decade rather than better. Closing this gap requires more than symbolic awareness campaigns. It requires research that includes women from the start, diagnostic tools built around female physiology rather than retrofitted to it, and medical training that treats women's heart health as a core competency rather than a specialty afterthought. As someone planning to go into cardiothoracic surgery, I see this not just as a research topic but as a problem I'll be responsible for addressing directly, one patient at a time.

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