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The Behavioral Architecture of Dietary Salt Reduction Among Hypertensive Population in Sabah, Malaysia: A Descriptive Qualitative Inquiry

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hypertension, dietary salt, behavioral architecture, qualitative inquiry, Sabah

Abstract. Dietary patterns, not medical adherence, make it dif8icult to reduce salt in the population. This is due to the complex structure of the house. Hypertensive residents living in communities in Sabah, Malaysia, have dif8iculty adhering to a low-salt diet due to factors such as family kitchen dynamics, barriers in multi-level behavior, and barriers in the local food environment. Using a descriptive qualitative investigative framework compatible with COREQ principles, we conducted semi-structured face-to-face and telephone interviews with a purposive sample of N=10 individuals diagnosed with home-cooked hypertension. Thomas and Harden's three-stage inductive theme framework has been used to process the transcript verbatim. These transcripts have also been mapped to external settings of the Socio Ecological Model and CFIR 2.0. Four main themes of non-compliant architecture are shown in inductive thematic analysis: Interpersonal Friction and the Stress of Collective Family Food Sharing, in which family tastes override medical needs; The Socioeconomic Gap and Architectural Barriers of Retail Choices, which emphasises that ultra processed high-salt products are cheaper and more readily available in Sabah's retail market than fresh low-salt products. Dietary non compliance is structural design, not motivation. Public health and clinical nurse leaders must transition from didactic counseling to supporting family choice-architecture interventions and regional food policy changes to ease the cognitive and economic constraints of salt restriction. Finally, this study supports a tactical shift towards community-based support systems that consider local eating habits for better health outcomes in the long run.

Introduction

Hypertension, which causes disability-adjusted life years (DALY) and high mortality, is the largest cause of premature death and preventable long-term cardiovascular disease worldwide (Isa et al., 2021; Lim et al., 2004). There is evidence that excess salt is a modiJiable risk factor for chronic high blood pressure (Lou et al., 2022). Average reduction in arterial pressure, ischemic stroke, and acute myocardial infarction is reduced with population-level salt reduction, according to signiJicant clinical data (Muga & Kiyu, 2021; Oku et al., 2024). To alleviate this public health issue, the daily salt intake should be less than 5 g (World Health Organization, 2023). Nationwide average intake exceeds recommended levels (Institute of Public Health [IPH], 2020; World Health Organization, 2023). This happens despite pre-set limits.

Dietary restrictions help physiologically, but dietary adjustments are difJicult to make over a long period of time (Ambigapathy et al., 2019; Sanuade et al., 2024). In clinical studies, a key cognitive-behavioral paradox has been demonstrated. Most people with hypertension are aware of the risks of excess salt to cardiovascular health, but they do not

make an effort to change the way they act daily (Delahanty, 2020; Kawabata et al., 2024). Didactic clinical counseling and personal intentions do not inJluence dietary choices, according to this recurring breakdown (Anderson et al., 2021). On the other hand, eating habits are inJluenced by structural reality, socio-cultural identity, local environmental conditions, and interpersonal interactions (Anderson et al., 2021; Stokols, 1996).

Behavioral Architecture and Choice Architecture

Physical and social environments are created to encourage health-promoting behaviors without compromising human agency or freedom (Luta et al., 2017). Tableware design, commercial portion size regulations, and strategic retail product positioning are architectural features in the study of the modern food environment (Chau et al., 2015). SigniJicant nutritional cues in real-time can impact a user's choices without affecting their conscious cognition (Chau et al., 2015; Powell et al., 2015). However, fewer studies have been conducted on the strategic behavioral architecture for dietary salt limits (Sonuch et al., 2024). This is especially true in communities diagnosed with hypertension, which face complex socio-cultural and economic problems (Youngiam & Therawiwat, 2023). Analysis of how shifting external environments impact patients' daily routines, household food choices, and structural constraints is essential to implementing equitable and sustainable public health interventions (Damschroder et al., 2022; Youngiam & Therawiwat, 2023).

Implementation Science Perspectives

The Jive main domains of the Consolidated Framework for Implementation Research (CFIR 2.0) are innovation, external environment, internal environment, individual, and implementation processes (Damschroder et al., 2022). Contextual compatibility in the patient ecosystem is more important than medical efJicacy for public health success, according to a study that used CFIR lenses to study dietary salt restriction (Damschroder et al., 2022). Home workJlows, regional food supply chains, and community economic realities are important (Damschroder et al., 2022). Community-based salt reduction initiatives often face challenges such as local socio-economic disparities that hinder access to fresh produce; unclear labeling of nutrition on processed foods; and a heritage of deep-rooted cuisines that go against low-salt guidelines (World Health Organization, 2023). However, community leadership networks and social support systems aid implementation (Aarons et al., 2011; World Health Organisation, 2023). Synthesising multilevel contextual elements helps researchers uncover structural prerequisites for lifestyle interventions (Al-Sabbah, 2024).

Health Literacy and Knowledge Translation

The ability to obtain, interpret, appraise, and use complicated health information to guide everyday lifestyle decisions is called health literacy (Nutbeam, 2008). The empirical connection between objective dietary salt measurements and baseline health literacy is inconsistent in current studies (Isa et al., 2021). High cognitive awareness of heart disease risk is associated with advanced health literacy. However, secondary operational support is needed to transform abstract information into persistent behavior (Aarons et al., 2011; Nutbeam, 2008). High internal self-efJicacy, rapid social and environmental reinforcement, and practical and practical skills such as reading complicated nutrition labels and making salt-free foods are all the results of this translation (Delahanty, 2020). Educational interventions must go beyond the distribution of information because there is a huge gap between individual knowledge and group home behavior (Delahanty, 2020). Researchers need to assess and overcome the barriers to real-world operations that work at home (Aarons et al., 2011; Delahanty, 2020).

Socio-Cultural and Structural Determinants

The human diet is inJluenced by the cultural identity and traditional social activities of the family. Home dynamics usually exceed medical requirements and replace salt restriction measures (Delahanty, 2020). Traditional food preparation methods, especially in regional or ethnic minority communities, using salty ingredients, natural spice blends and historical preservation methods, are culturally important and should not be replaced by clinical advice (Ambigapathy et al., 2019; World Health Organization, 2023). Chronic Jinancial constraints, systemic food shortages, and damaged local food ecosystems make maintaining dietary adjustments more challenging (Sanuade et al., 2024). Limited access to raw and fresh materials occurs in cases of geographically isolated hypertension or socioeconomic deprivation (Anderson et al., 2021; Muga & Kiyu, 2021). Inexpensive, very tasty and ultra-processed commercial products usually cater to their environment (Strazza et al., 2021). Although they have a strong desire to maintain health and knowledge of the cardiovascular system, vulnerable groups face difJiculties in maintaining a low-salt lifestyle due to environmental barriers (Sanuade et al., 2024; Stokols, 1996).

Research Problem

Current dietary compliance data are fragmented and disconnected from real-world domestic settings in regional Malaysian contexts (Isa et al., 2021; Lim et al., 2004). Health administrators cannot create targeted, structurally supporting nursing treatments due to fragmentation (Al-Sabbah, 2024). This study uses a robust, observational qualitative methodology to collect primary Jield data in Sabah to close this gap (Thomas & Harden, 2008). This study creates a behavioral taxonomy using rich, descriptive qualitative data on household kitchen dynamics (QSR International, 2022). This research uses participant voices to identify implementation gaps between evidence-based cardiovascular guidelines and real-world household routines, driving culturally adaptable public health nursing interventions.

Objectives of the Study

This study seeks to discover and assess the multi-level factors that affect hypertensive Sabah residents' salt restriction adherence. The speciJic objectives are:

1. To analyse the primary individual, interpersonal, and socio-cultural barriers that dictate how hypertensive patients navigate daily salt restrictions within their domestic kitchens.
2. To analyse the primary individual, interpersonal, and socio-cultural barriers that dictate how hypertensive patients navigate daily salt restrictions within their domestic kitchens.
3. To evaluate how environmental changes, decision architecture frameworks, and behavioral architecture nudging tactics can be deployed to facilitate sustained dietary salt reduction.

Assumptions of the Study

All hypertensive participants in the study are assumed to reJlect community-dwelling adults in non-institutionalised Sabah. We assume that participants have real administrative control or active co-sharing over their methods of preparing food in the household and that their descriptive interview responses are representative of their real everyday kitchen routines, Jinancial decisions, and dietary struggles in the absence of substantial recall bias or social desirability bias.

Conceptual Framework

We base our study on the Socio-Ecological Model and the outer settings area of the Consolidated Framework for Implementation Research (CFIR 2.0) (Damschroder et al., 2022; Stokols, 1996). Using this approach, dietary adherence is seen as a complex system with psychological factors (for example, reading and taste preferences) enclosing the patient's biological core. Social pressures (family meals) and macro-environmental factors like retail market availability and regional economy directly structure them (Institute for Public Health [IPH], 2020; World Health Organisation, 2023).

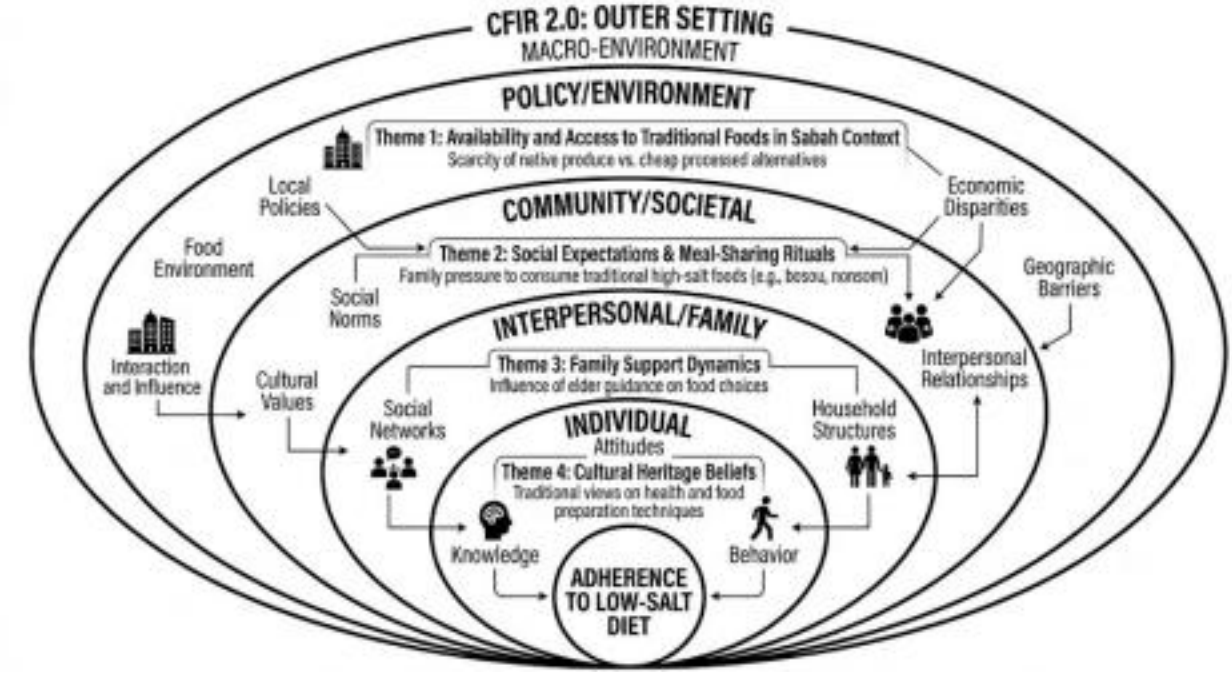

Figure 1: Socio-Ecological Mapping of Dietary Salt Adherence Within the CFIR 2.0 Outer Setting Framework

Methodology

Research Design

This is a qualitative primary study. The framework concentrated on investigating and understanding the intricate behavioral architecture, socio-cultural norms, and routine domestic implementation obstacles faced by individuals adhering to salt restriction rules within their own homes. This study followed the Consolidated Criteria for Reporting Qualitative Research (COREQ) recommendations for reporting transparency and clinical research rigor (Tong et al., 2007).

Research Locale

The study was based on three districts, Kota Marudu (n=3), Ranau (n=4), and Telupid (n=3), in Sabah, Malaysia, community clinics, and residential health facilities. The cultural and socio-demographic diversity of these locations allows for an accurate understanding of the retail context and cooking practices in the region.

Participants

This study used targeted purpose sampling and critical case selection frameworks. To provide comprehensive contextual insights into how to implement real-world nutrition guidelines, this targeted method selects data-rich examples.

- Inclusion Criteria: Malaysians aged 18 years and above, permanently resident within the state of Sabah, with a valid clinical diagnosis of hypertension and with primary or shared operational control over home grocery purchase and kitchen meal preparation decisions.
- Exclusion Criteria: In-hospital feeding units, metabolic clinical kitchens, and long-term care institutions; salt monitoring patients were excluded. This situation lacks the necessary autonomy to discuss the architecture of choice in a complex household social environment.
- Conceptual and thematic saturation, rather than statistical power, inJluences sample size. In the Jinal cohort of ten cases, data collection and open coding were performed simultaneously. Repeated line-by-line analysis shows that further interviews do not produce new conceptual elements, structural barriers, or codes of behavior.

Data Gathering Procedure

Face-to-face semi-structured interviews and focused focus group discussions collected primary qualitative data. The interview guide was evaluated by subject matter experts to ensure content relevancy and clarity during all interaction sessions. Participants met in pleasant, quiet spaces to promote open discussion and reduce social desirability bias. Audio recordings were made with signed participant consent and transcribed verbatim for analysis.

Data Analysis

The conJirmed verbatim transcripts were organised and processed in qualitative data analysis software (NVivo version 14) (QSR International, 2022). The data underwent a thorough inductive thematic analysis using Thomas and Harden's (2008) three-stage approach. Familiarisation, Jirst coding, topic identiJication, evaluation, reJining, and Jinishing the qualitative report comprised the analytical process (Braun & Clarke, 2006). The Jinal behavioral taxonomy was mapped between the Socio-Ecological Model and CFIR 2.0's outer settings domain to contextualise implementation determinants after inductive theme development (Damschroder et al., 2022; Stokols, 1996). Table No. 1 chronologically shows the external audit workJlow from raw text immersion to Jinal theme generation.

Phase Number	Operational Phase Name	Analytical Activities and Methodological Specifications
1	Immersive Familiarisation	Conducting iterative, repetitive reading of the raw verbatim transcripts to achieve complete research team immersion in the field data.
2	Initial Open Coding	Generating systematic, line-by-line open codes pinned directly and securely to the raw, targeted participant data strands.
3	Descriptive Code Aggregation	Aggregating and clustering initial descriptive codes into broader, interconnected candidate categories.
4	Structural Reviewing	Reviewing and evaluating candidate themes directly against the explicit research objectives to map clear analytical boundaries.

5	Thematic Refinement	Performing iterative refinement of conceptual definitions to establish distinct, non-overlapping analytical boundaries between nodes.
6	Final Synthesis	Constructing the final behavioral taxonomy using representative verbatim source quotations to fully preserve the authentic participant voice.

Table No. 1: Sequential Phases of Inductive Thematic Analysis Framework

Results and Discussion

Organizing Results

The Socio-Ecological Model Stage and the external setting of the Consolidated Framework for Implementation Research (CFIR 2.0) cover four main analytical themes derived from the data. A strong behavioral taxonomy showed a multi-stage barrier to dietary salt restriction (N=10), according to an inductive analysis of word-by-word transcripts performed on a critical case hypertension target group. The target group consisted of four male and six female volunteers, aged between 38 and 67, from various ethnic groups in Sabah, including Malaysian Chinese, Bajau, and Kadazan-Dusun. The analytical framework for this conclusion before the cross-case synthesis of the narrative is shown in Table 2.

Analytical Theme	Socio-Ecological Domain	Critical Case Representative Empirical Data Strands
1. Availability and Access to Traditional Foods	Macro-Level (CFIR 2.0 Outer Setting)	• *"Canned sardines, instant noodles, and dried fish are what we can afford... Fresh low-salt meat costs double."* (Participant 01) • *"Mini-marts are packed with salty snacks... Finding a 'low-salt' label is almost impossible."* (Participant 09)
2. Social Expectations & Meal-Sharing Rituals	Meso-Level (Community & Interpersonal)	• *"I am the main cook for seven people... If I don't put traditional fish paste, my family complains. I cannot afford to cook two separate meals."* (Participant 03) • *"Social pressure to conform to the family palate completely overrides my doctor's warnings."* (Participant 07)
3. Family Support Dynamics	Meso-Level (Interpersonal & Family)	• *"In our home, the elders hold the final word on what ingredients enter the kitchen. When they insist on heavy salt for preservation, it is difficult to challenge them."* (Participant 04) • *"Without proactive help from my family to adjust the communal pot, trying to isolate my food makes me feel completely disconnected."* (Participant 08)
4. Cultural Heritage Beliefs	Micro-Level (Individual Attributes)	• *"How am I supposed to calculate five grams when using traditional sauces?... The numbers on packets are confusing and too small. You get tired and give up."* (Participant 05) • *"We have prepared our food this way for generations; it is hard to believe that a basic ingredient like salt is the sole cause of my high blood pressure."* (Participant 10)

Table No. 2: Inductive Behavioral Taxonomy and Representative Data Strands

Theme 1: Availability and Access to Traditional Foods in Sabah Context

In the larger context, Sabah's economic structure and its retail supply chain are the biggest border challenges. Structural stress associated with home food preparation is a major obstacle in 90% of interviews. Not only did participants see challenges in therapeutic nutrition, but they also consistently saw that the household nutrition hierarchy encouraged family food sharing. When it comes to domestic workJlows, preparing dishes with a low amount of salt is a huge logistical task, and reducing the amount of salt in a home pot often leads to disagreements in families. On the other hand, forcing each family to follow a low-salt diet often leads to conJlict in the family because it affects the way families cook together (Ambigapathy et al., 2019; Muga & Kiyu, 2021). These structural barriers indicate that due to economic problems, the modiJication of an individual's diet is very limited. This supports the idea that, rather than a will, the food supply chain should be the focus of public health strategies.

"Foods such as dried \ish, canned sardines, and instant noodles are cheap and do not spoil. The price of organic herbs and fresh unsalted meat has almost doubled in the local market. Now my family doesn't have the money to buy nutrient-rich food." (Participant number one, 38-year-old male).

"The adjacent mini market is full of snacks, salts, and processed sauces. Labels indicating "low salt" are almost impossible in this location. Even if you want to buy it, our village grocery store doesn't stock cheap salt." (Participant 09, Female, 47 years old)

Theme 2: Social Expectations & Meal-Sharing Rituals

Participants found basic structural barriers in Sabah's local retail market. Neighborhood markets and mini-markets sell highly processed and tasty products with hidden preservatives and salts at lower prices and with a longer shelf life. These products are produced from fresh produce or lower-salt alternatives (Institute of Public Health [IPH], 2020; Muga & Kiyu, 2021). This choice of structure deliberately punishes vulnerable socioeconomic groups by limiting salt consumption to harmful levels, despite strong health motivations. This supports the point of view of implementation science in the internal and external contexts of CFIR 2.0, which suggests that individual health interventions are ineffective when they conJlict with collective socio-cultural networks (Damschroder et al., 2022).

"I am the main cook of the house for the seven people who live there. My husband and kids immediately complained that if I didn't add traditional \ish paste or soy sauce to the meal, it tasted like hospital food or paper food. I couldn't cook two different dishes every evening, so I just ate what they ate and prayed that my blood pressure would stay safe." (Participant 03, 54-year old female)

"One way in our culture to maintain family unity is to eat together. When I refused a certain traditional salted \ish dish during a gathering, my relatives thought I was arrogant or separate from society. The social pressure to go against the family's tastes really overcame my doctor's warnings." (Participant number 07, a 62-year-old man)
Theme 3: Family Support Dynamics

Although 80% of participants knew that excessive salt intake increased the risk of heart disease, there were signiJicant differences in how they used this abstract information in their daily lives. By using confounding clinical measures (such as grams or teaspoons) in the context of actual cooking, participants experienced signiJicant cognitive difJiculties when trying to understand complicated sets of snacks or accurately estimate their daily salt targets (Institute of Public Health [IPH], 2020). This suggests that family-centered therapy is important because treating patients individually ignores the interpersonal relationships that govern daily diet and emotional resilience (Delahanty, 2020).

"The parents in our house hold the last word on what goes into the kitchen. It's very dif\icult to argue with them or explain modern blood pressure guidelines when they say that we need to use heavy salt for preservation or \lavor." (Participant 04, male, 59 years)

"Without the proactive help of my partner and children, tracking down salt became a lonely battle. It makes me feel completely isolated from my family when they eat regular food in front of me, whereas I eat regular food without salt." (Participant 08, Female, 41 Years).

Theme 4: Cultural Heritage Beliefs

80 percent of participants understood the theoretical relationship between salt and cardiovascular risk, but applying this knowledge to practices that require mental resources was difJicult. This is due to differences in the translation of knowledge-behaviors and long-held concepts of cultural heritage about food preparation. Ambiguous microscopic nutritional labeling on commercial products or the need to quantify the salt content that is not apparent in traditional native foods (such as bosou or nonsom) creates signiJicant cognitive difJiculties and encourages people to rely on generational traditions full of salt (Institute of Public Health [IPH], 2020; Muga & Kiyu, 2021). The results show that theoretical medical instruction does not solve the problem of home implementation in the real world (Delahanty, 2020). To reduce cognitive load and facilitate compliance, educational models should provide tactile "encouragement", such as color-coded measuring spoons or native language visual cues (Powell et al., 2015).

"The nurse advised me to minimise the intake of Jive grams of salt per day. But how can I count Jive grams when I put ingredients in a large pot of traditional soup or buy food from a local stall? The numbers on the back of plastic food packages, which are written in small print and require math, can be confusing. You end up getting tired of counting every bite." (Participant number 05, 45-year-old male)

"Our traditional foods have been cooked this way for generations, and our ancestors have lived a long time. Believe that salt is the only cause of my high blood pressure, and it's hard to break this habit. When medical advice seems too abstract and disconnected from our traditional lifestyles, it's easy to default on what we know." (Ten participants, all female, aged 61)

Conclusion and Recommendations

Conclusion

The complex anatomical and behavioral elements responsible for limiting salt restriction in hypertensive patients are shown in this study. Qualitative Jindings show that nutritional non-compliance is essentially an environmental response to the architecture of inappropriate choices. These results were obtained by going beyond speciJic motivation models and using integrated Socio-Ecological and CFIR 2.0 frameworks. Macroenvironmental retail constraints such as income gaps and lack of market visibility of salt alternatives hinder raw food choices, according to an inductive taxonomy. If trying to isolate therapeutic cooking at home, it can lead to signiJicant conJlicts between individuals due to household eating hierarchy and cultural customs embedded in social food sharing. The dynamics of family support, which are strongly inJluenced by the advice of the parents' herbs, also affect adherence. At the individual level, there are differences in the translations of knowledge-behavior due to extreme cognitive fatigue caused by systemic and meso-macro stresses. As a result, despite the unknown cardiovascular dangers, patients have continued to maintain high-salt habits for generations.

Implications for Clinical Nursing Practice and Public Health

The results show that cardiac nursing and public health require a shift away from didactic counseling. Clinical nurse leaders must move beyond the daily milligram limit to a family-centered preferred architectural method that works.

- Family-Centered Nutrition Co-Adaptation: In addition to treating patients, nursing interventions should involve primary household cooks and family parents, portraying recipe changes as collaborative health projects to reduce tension between people.
- Tactile and Cognitive Nudges: Simple, native-language visual food guidance and color-coded measuring scoops calibrated to traditional Sabah cooking operations can reduce cognitive fatigue and bridge the translation gap.
- Macro-Level Retail Advocacy: These structural insights can help public health executives and clinical nurse leaders argue for local policy reforms, such as giving incentives to community mini-marts to carry visible, affordable low salt options.

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Competing Interests Statement

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Data Availability Statement

Participant confidentiality agreements and strict institutional review board rules prevent the public release of the qualitative datasets (raw verbatim audio-recorded transcripts and analytical NVivo codebooks) created and analysed in this study. Data are available from the corresponding author upon reasonable academic inquiry.

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Appendices

No appendices are attached to this study.