

A CROSS-SECTIONAL STUDY ON INDICATORS OF HEALTH AND WELLBEING AMONG SELECTED ARTISANAL FISHERWOMEN OF RAMANATHAPURAM DISTRICT, TAMIL NADU, INDIA

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Abstract

Health is a key human development indicator influenced by occupational exposures, environmental conditions and access to healthcare. This cross-sectional study has assessed nutritional indicators, diet quality, cardiometabolic risk and quality of life among 400 artisanal fisherwomen in Ramanathapuram District of Tamil Nadu, India. Data has been collected using a standardized interview schedule for assessment of nutritional status, abdominal obesity, self-reported medical history, the Diet Quality Questionnaire and WHOQOL BREF (1996). Descriptive statistics and chi-square analysis are used to assess the associations between quality of life and health status. Nearly half of participants have had a normal body mass index (47%), while about 33 percent are overweight and 11 percent are obese. Indicators of abdominal obesity have shown increased risk based on waist-hip ratio (50%) and waist-height ratio (58%). Diet quality scores have shown only minor variations across occupation groups. Age-wise analysis of blood pressure has revealed a progressive increase in hypertension with advancing age; with Stage II hypertension observed among fisherwomen aged above 50 years (18%). Despite these risks, 77.5 percent rated overall quality of life as good. Chi-square analysis has shown significant associations between quality of life and diabetes mellitus ($\chi^2 = 21.20$, $p < 0.001$), hypertension ($\chi^2 = 10.92$, $p = 0.004$) and comorbidity ($\chi^2 = 13.81$, $p = 0.003$). Cramer's V has indicated a moderate association between diabetes and quality of life ($V = 0.23$). These findings indicate that although many fisherwomen perceive their quality of life positively, cardiometabolic risk factors remain prevalent. These results highlight the importance of targeted health screening and preventive interventions addressing nutritional status and cardiometabolic risk among artisanal fisherwomen.

Keywords: Abdominal obesity; Advancing age; Comorbidity; Hypertension; Quality of Life

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Introduction

Health and wellbeing are multidimensional concepts encompassing physical, mental and social dimensions that reflect the overall functioning of individuals within their social and environmental context (WHO, 1948). In population-based research, these dimensions are assessed using multiple health indicators that collectively provide insights into health status and risk patterns within specific communities (Pan American Health Organization, 2018).

Fishing communities are among the most occupationally susceptible groups in coastal locations, with livelihoods shaped by environmental instability, informal labor patterns and limited access to established health systems. Although women are not frequently involved in direct fishing operations, they play a crucial yet undervalued role in maintaining home and community health. Fisherwomen are often the first to notice physical strain, psychological discomfort and mental health issues among fishers because they are spouses, caregivers and community members. They play a crucial role in promoting health-seeking behavior by introducing health information through unofficial, trust-based “soft entry points,” especially in situations where formal healthcare involvement is either delayed or limited (Chambon *et al.*, 2024).

Women’s health needs and vulnerabilities are still mostly unseen in fisheries health research. In India, the fisheries sector employs about 5.4 million people, with roughly one-third of them being fisherwomen who work mostly in post-harvest tasks such as peeling, cleaning, processing, trading and marketing seafood. Long labor hours, repetitive motions, exposure to cold and dampness and a lack of ergonomic precautions are characteristics of these occupations. There is a gendered distribution of occupational risks in the fishing industry, with evidence repeatedly showing that women are more likely than males to suffer from musculoskeletal problems, exhaustion and cold-related illnesses (Tripathi *et al.*, 2017).

Socioeconomic disadvantage exacerbates health risks for fisherwomen. The necessity for therapies that specifically combine gender and socioeconomic vulnerability is highlighted by life-course evidence that suggests people from lower socioeconomic strata acquire risk factors for chronic illnesses including overweight and obesity (Amigo *et al.*, 2018). Even among young adult populations, correlations between blood pressure and body composition indicators have been proven at the physiological level showing predictive value for cardiovascular risk (Dahel-Mekhancha *et al.*, 2023).

While these findings emphasize the importance of fundamental health indicators in early risk detection, such multi-dimensional assessments remain limited among occupationally marginalized groups such as artisanal fisherwomen.

Despite growing evidence on occupational health risks among fishing populations, research examining the multidimensional health status of artisanal fisherwomen remains limited. Existing literature has largely focused on specific occupational hazards or single health outcomes, while comprehensive assessments integrating nutritional status, cardiometabolic risk indicators and quality of life are scarce. Moreover, empirical data on the health profile of artisanal fisherwomen in coastal regions of Tamil Nadu are particularly limited. Addressing this gap is crucial for understanding the health vulnerabilities of this occupationally marginalized group. Therefore, the present study aims to assess key indicators of health and wellbeing, including nutritional status, diet quality, cardiovascular risk factors and quality of life among selected artisanal fisherwomen in Ramanathapuram District of Tamil Nadu, India.

Methodology

Study Design and Sample

A community-based cross-sectional study has been conducted among artisanal fisherwomen in selected coastal villages of Ramanathapuram District, Tamil Nadu, India. Ramanathapuram District is characterized by diverse fishing practices and a strong livelihood dependence on marine fisheries contributes nearly 23.7 percent of state’s fisher population. This makes it a relevant setting for studying fisherwomen.

Simple random sampling has been used for the selection of samples. The sample frame has been derived from Marine Fisheries Census. According to the census, Ramanathapuram District, Tamil Nadu, India has a total fisher population of 188,915, including 66,884 fishermen and 62,019 fisherwomen. The required sample size is calculated using the Yamane (1967) formula with a margin error of five percent which yielded a sample size of 397 fisherwomen. For ease of sampling and analysis, the sample size is rounded to 400 participants. Selected coastal villages including Devipattinam, Rameshwaram, Mandapam, Pamban, Pudumadam, Muthupettai, Kuthukkalvalasai, Thondi, Tiruppalaikudi, Kadaladi, Alagankulam, Sethukarai, Keelakarai, Ervadi and Valinokkam are

included in the study based on their fishing population and with permission obtained from respective village heads. The samples are selected randomly from each coastal village.

To account for possible non-response and incomplete data, approximately 420 fisherwomen have been initially approached, resulting in a final sample of 400 participants included in the analysis.

Study Ethics

The study has been approved by Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India (Approval No. AUW/XMT-038, FSMD/IHEC/23–24). Prior to data collection, all selected fisherwomen ($n = 400$) have been informed about the objectives and procedures of the study and both written and oral informed consent are obtained. Participation in the study is voluntary, and confidentiality of the participant's information was ensured. Face-to-face interviews were conducted for approximately 30 minutes, including the assessment of anthropometric indicators. Data collection is carried out in selected coastal villages from February 2024 to November 2025. The study procedures are conducted in accordance with the ethical principles of Declaration of Helsinki.

Study Tools and Variables

The structured interview schedule is used for collecting basic demographical data, occupational profile, self-reported medical history and adopted WHOQOL BREF tool for the perception towards physical, psychological, social and environmental health domains. The interview schedule is pretested and has shown acceptable internal consistency (Cronbach alpha value = 0.69) and content validity (CVI = 0.96). Health indicators such as age, waist circumference, waist-hip ratio, waist-height ratio, body mass index are calculated after recording the measurements of selected fisherwomen. The self-reported medical history is cross-verified with medical records of selected artisanal fisherwomen (Secondary Data).

Indicators of abdominal obesity are classified according to World Health Organization (2011), Ashwell and Gibson (2016). The classification criteria and cut-off values used in the present study are presented in Table 1. Body mass index, or kg/m^2 , is a straightforward anthropometric measure that is computed as the ratio of body weight in kilograms to the square of height in meters. A body mass index of 18.5 to 24.9 kg/m^2 is associated with the lowest risk of death, according to World Health Organization guidelines; values of 25 kg/m^2 or

above indicate overweight and values of 30 kg/m^2 or more indicate obesity (WHO, 2011).

Table 1. Indicators of Abdominal Obesity

Abdominal Obesity	Waist Circumference (cm) (Ashwell & Gibson, 2016)	Waist-Hip Ratio (WHO, 2011)	Waist-height ratio (Ashwell & Gibson, 2016)
Low Risk	<80	<0.80	<0.5
Increased Risk	80-88	0.81-0.85	0.5-0.6
Very High Risk	>88	>0.85	>0.6

Diet quality is assessed using the adapted Diet Quality Questionnaire (DQQ) developed by Global Diet Quality Project. It is a standardized tool using a 24-hour recall with dichotomous (Yes/No) across 29 food groups (Adeyemi *et al.*, 2025). Based on the responses, two indicators are computed: Non-Communicable Disease Protect Score (0-9) and Non-Communicable Disease Risk Score (0-9). These indicators collectively assess diet quality and dietary risk related to non-communicable Diseases.

Blood Pressure is assessed as a key cardiometabolic indicator among selected artisanal fisherwomen using a calibrated Omron digital sphygmomanometer. The fisherwomen are asked to be seated comfortably and allowed to rest for at least five minutes prior to measurement. The blood pressure is measured three times after five-minutes rest and the average of the three readings is recorded and used for analysis. The readings are classified based on the American College of Cardiology and American Heart Association guidelines, which define normal blood pressure as systolic blood pressure below 120 mmHg and diastolic blood pressure below 80 mm Hg. Elevated blood pressure is characterized by systolic blood pressure of 120 to 129 mmHg with diastolic blood pressure below 80 mmHg. Stage one hypertension is defined by systolic blood pressure between 130 to 139 mmHg or diastolic blood pressure between 80 to 89 mmHg, while stage two hypertension is defined by systolic blood pressure of 140 mmHg or higher or diastolic blood pressure of 90 mmHg (Whelton *et al.*, 2018).

For assessing the wellbeing indicator, WHOQOL BREF (1996) tool is used. It is a standardized and validated instrument for different cultural settings, developed by World Health Organization and licensed under WHO/HIS/HSI Rev.2012.03. It consists of 26 items covering four domains of health namely physical, psychological, social and environmental wellbeing and is available in over 40 languages for cross cultural comparison. The selected fisherwomen are asked to rate their

perception on a five-point scale which is then transformed to 0 to 100 scale using WHO syntax. Mobility, daily activities, energy, pain and sleep are all included in the physical domain; self-image, attitudes, self-esteem and cognitive abilities are evaluated in the psychological domain; personal relationships and sexual life are covered in the social domain; and money, safety, healthcare access, living conditions, personal growth, pollution and transportation are all included in the environmental domain, which offer a thorough evaluation of overall wellbeing in a variety of contexts. The transformed scores are then classified as very good (scores above the 75th percentile), moderately good (scores between the 75th and 50th percentile), moderately poor (scores between the 50th and 25th percentile) and very poor (scores below the 25th percentile) (Shah *et al.*, 2017).

Data is analyzed using Statistical Package for the Social Sciences (SPSS) version 21. Descriptive statistics such as mean, standard deviation, frequency percentages are used to summarize the demographic characteristics and health indicators of selected fisherwomen. The association between categorical variables such as self-reported medical history and

quality of life categories is examined using chi-square analysis. The chi-square test is selected as it is appropriate for assessing associations between categorical variables. The assumptions of chi-square test including independence of observations and adequate expected frequencies are checked prior to analysis. In addition to p value, effect size measures (Cramer's V) are considered for strength of associations. Statistical significance is considered at $p < 0.05$.

Results and Discussion

Results

The present study has assessed various health and wellbeing indicators among selected artisanal fisherwomen ($n = 400$) of Ramanathapuram District of Tamil Nadu, India.

Table 2 presents the nutritional indicators of selected fisherwomen. Most of the selected fisherwomen are in the age group of 50 to 59 years. Nutritional assessment has shown that nearly half of the participants had normal body mass index ($18 - 24.9 \text{ kg/m}^2$), while indicators of abdominal obesity suggest that a considerable proportion of fisherwomen are at increased risk.

Table 3 presents the diet quality scores across occupation groups of selected artisanal fisherwomen. The mean Non-Communicable Disease Protect Score is relatively similar across occupational activities, ranging from 2.90 ± 1.20 among fisherwomen involved in seaweed collection to 3.46 ± 1.33 among those engaged in sales. Similarly, the NCD Risk Score has shown minor variation across occupational groups.

Table 2. Nutritional Indicators of Artisanal Fisherwomen

Nutritional Indicators	Frequency	Percent
Age (Years)		
Mean $\pm$ S.D	45.19 $\pm$ 10.2	
20 - 29	32	8
30 - 39	90	22.5
40 - 49	126	31.5
50 - 59	152	38
Waist Circumference*		
Mean $\pm$ S.D	81.08 $\pm$ 9.67	
Low risk	178	44.5
High risk	131	32.8
Very high Risk	91	22.8
Body Mass Index[^]		
Mean $\pm$ S.D	24.4 $\pm$ 4.5	
Underweight	40	10
Normal	186	46.5
Overweight	130	32.5
Grade I obese	40	10
Grade II obese	3	0.8
Grade III obese	1	0.3
Waist-hip ratio[^]		
Mean $\pm$ S.D	0.85 $\pm$ 0.11	
No risk	199	49.8
Increased risk	201	50.2
Very high risk	0	0
Waist-height ratio*		
Mean $\pm$ S.D	0.54 $\pm$ 0.06	
No risk	83	20.8
Increased risk	232	58
Very high risk	85	21.3

*Ashwell and Gibson (2016), [^]WHO (2011)

Table 3. Diet Quality Scores across Occupation Groups of Artisanal Fisherwomen

Dietary Quality Vs Occupation	NCD Protect Score	NCD Risk Score
Net Knitting & Repairing	3.41 $\pm$ 1.29	0.61 $\pm$ 0.93
Fishing	3.34 $\pm$ 1.43	0.61 $\pm$ 0.99
Collection of Seaweeds	2.90 $\pm$ 1.2	0.82 $\pm$ 1.03
Sales	3.46 $\pm$ 1.33	0.76 $\pm$ 0.99
MGNREGA	3.04 $\pm$ 1.15	0.63 $\pm$ 0.95

Table 4 presents the age-wise stratification of blood pressure. Normotension is more common among younger women aged 20 to 39 years (4 to 10%), while elevated blood pressure and stage I hypertension are more frequently observed in the 40 to 49 years of age group (8%). Stage II hypertension is predominantly observed among fisherwomen aged above 50 years (18%).

The distribution of quality of life among the selected fisherwomen is presented in Table 5. Most participants have reported satisfaction with their health and majority rated their physical, psychological, social, environmental and overall quality of life as good.

The association between perceived health problems and overall quality of life is presented in Table 6. Chi-square analysis has indicated significant associations between quality of life and

diabetes mellitus ($\chi^2 = 21.20$, $p < 0.001$), hypertension ($\chi^2 = 10.92$, $p = 0.004$) and comorbidity ($\chi^2 = 13.81$, $p = 0.003$). Effect size analysis using Cramer's V indicated a moderate association for diabetes ($V = 0.23$) and small associations for hypertension ($V = 0.17$) and comorbidity ($V = 0.19$). No significant association has been observed between overall quality of life and cardiovascular diseases, arthritis or thyroid disorders.

Table 4. Age wise Stratification of Blood Pressure Profile of Artisanal Fisherwomen

Blood Pressure Profile	Age (Years) (n(%))				Total
	20 - 29	30 - 39	40 - 49	> 50	
Hypotensive	0	0	0	1	1 (0.3)
Normotensive	17 (4.3)	41 (10.3)	38 (9.5)	28 (7)	124 (31)
Elevated Blood Pressure	6 (1.5)	12 (3)	26 (6.5)	19 (4.8)	63 (15.8)
Stage I	4 (1)	17 (4.3)	33 (8.3)	31 (7.8)	85 (21.3)
Hypertensive					
Stage II	5 (1.3)	20 (5)	29 (7.3)	73 (18.3)	127 (31.8)
Hypertensive					

Table 5. Quality of Life of Selected Artisanal Fisherwomen

Quality of Life	Frequency	Percent
Health Satisfaction		
Mean $\pm$ S.D	3.89 $\pm$ 1.5	
Very Satisfied	15	3.8
Satisfied	299	74.8
Neither Satisfied nor Dissatisfied	83	20.7
Dissatisfied	3	0.7
Very Dissatisfied	0	0
Perception of Physical QoL		
Mean $\pm$ S.D	74.84 $\pm$ 7.93	
Very Good	173	43.2
Good	221	55.3
Poor	6	1.5
Very Poor	0	0
Perception of Psychological QoL		
Mean $\pm$ S.D	73.26 $\pm$ 6.44	
Very Good	56	14
Good	338	84.5
Poor	6	1.5
Very Poor	0	0
Perception of Social QoL		
Mean $\pm$ S.D	75.18 $\pm$ 6.4	
Very Good	17	4.3
Good	373	93.3
Poor	10	2.5
Very Poor	0	0
Perception of Environmental QoL		
Mean $\pm$ S.D	63.41 $\pm$ 8.41	
Very Good	4	1
Good	367	91.8
Poor	29	7.3
Very Poor	0	0
Perception of Overall QoL		
Mean $\pm$ S.D	71.68 $\pm$ 5.94	
Very Good	84	21
Good	310	77.5
Poor	6	1.5
Very Poor	0	0

Table 6. Association of Quality of Life with Perceived Health Problems and Nutritional Indicators

Perceived Health Problems	Overall Quality of Life			χ^2	Exact p value	Cramer's V
	Poor	Good	Very Good			
Presence of Diabetes Mellitus						
Yes	4(1)	85(21.3)	6(2)	21.200	<0.001	0.230
No	2(0.5)	225(56.3)	78(20)			
Presence of Hypertension						
Yes	4(1)	102(25.5)	15(3.8)	10.920	<0.001	0.165
No	2(0.5)	208(52)	69(17.3)			
Presence of CVD*						
Yes	0	31(7.8)	8(2)	0.675	0.834	0.041
No	6(1.5)	279(69.8)	76(19)			
Presence of Arthritis						
Yes	1(0.3)	29(8.1)	8(2.2)	0.278	0.701	0.028
No	5(1.4)	244(67.8)	73(20.3)			
Presence of Thyroid						
Yes	0	4(1)	1(0.3)	0.082	1.000	0.014
No	6(0.5)	306(76.5)	83(20.8)			
Presence of Comorbidity						
Yes	4(1)	73(18.3)	9(2.3)	13.813	0.003	0.186
No	2(0.5)	237(59.3)	75(18.8)			

Discussion

The present study has assessed multiple indicators of health and wellbeing among artisanal fisherwomen in Ramanathapuram District, Tamil Nadu, India. The findings have revealed important patterns related to nutritional status, cardiovascular risk, quality of life and perceived health problems among selected artisanal fisherwomen. By examining these indicators simultaneously, the study highlights the complex interaction between occupational livelihood patterns and health outcomes in artisanal fisheries.

The selected fisherwomen have a mean age of 45 years; the anthropometric profile has revealed important patterns related to cardiometabolic risk. Although, nearly half of the fisherwomen are classified within the normal body mass index (47%, 24.4 ± 4.5 kg/m²), a substantial proportion are overweight (33%) or obese (11%). More importantly, over half of the selected fisherwomen have shown increased risk based on indicators of abdominal obesity, including waist-hip ratio (50%, 0.85 ± 0.11) and waist-height ratio (58%, 0.54 ± 0.06). The coexistence of normal body mass index with elevated central adiposity highlights the limitation of relying solely on body mass index for assessing cardiometabolic risk in this occupational group. The observed pattern may reflect livelihood conditions common in fishing communities including erratic eating habits, revenue fluctuations and physically taxing nature may affect household food supply and diet diversity. In addition, physically demanding occupation can result in energy imbalance and altered fat distribution which might affect long-term health and nutritional status (Béné *et al.*, 2016). Previous evidence has also

emphasized the importance of central adiposity indicators in identifying hidden cardiometabolic risk. Ashwell and Gibson (2016) have reported that individuals with normal body mass index but elevated waist-height ratio have significantly higher cardiometabolic risk. Similarly, a study by Thamer (2021) has also revealed that normal weight women have had high prevalence of central obesity highlighting the importance of assessing waist circumference, waist-hip ratio, waist-height ratio as sensitive indicators of abdominal adiposity.

Based on Global Diet Quality Project framework, the NCD protect and NCD Risk scores ranges from 0 to 9. Higher NCD-Protect scores indicate greater consumption of food groups associated with noncommunicable disease prevention. NCD-Risk scores reflect increased consumption of foods linked to disease risk. In the present study, both the observed mean scores of NCD Protect and NCD Risk are considerably lower than the maximum score, suggesting moderate but suboptimal dietary diversity and lower disease risk contribution through diet is observed among all occupational groups of artisanal fisherwomen. The observed pattern may reflect lower dietary diversity, income fluctuations, and occupational constraints within fishing communities (Bromage *et al.*, 2021).

Age-wise analysis of blood pressure profiles has indicated a progressive increase in elevated blood pressure and hypertension with advancing age. Normotensive status is more common among younger fisherwomen aged 20 to 39 years, whereas elevated blood pressure and stage I hypertension are more prevalent among those aged 40 to 49 years. Stage II hypertension is predominantly observed among fisherwomen aged above 50 years (18.3%)

suggesting a higher cardiovascular risk among older participants. Sundar *et al.* (2024) have reported that 39 percent of fishermen in Chennai are hypertensive, with increasing age and years of fishing experience are being identified as important risk factors, while awareness of the condition remains low. Rahaman *et al.* (2021) have also observed a higher prevalence of hypertension among fishers aged 40 to 50 years. The higher prevalence of hypertension among older fisherwomen in the present study may be attributed to age-related vascular changes and cumulative occupational strain associated with fishing-related activities. Fisherwomen are frequently engaged in physically demanding work involving fish processing, marketing and loading heavy weights (Saroj & Shivdikar, 2023). In addition, erratic dietary practices, high salt intake associated with preserved fish consumption and limited healthcare access may further contribute to increased hypertension risk among fishing communities (Kim, 2023; Sarnaik & Mirzai, 2025).

Despite the presence of nutritional and cardiovascular risk factors, perceptions of quality of life are largely positive among the selected fisherwomen. The quality-of-life mean score ranges from 63 to 75 indicating average to good quality of life across domain. About 75 percent of the fisherwomen have reported satisfaction with their health, while majority have rated their psychological health (85%, 73.26 ± 6.44), social health (93%, 75.18 ± 6.4), environmental health (92%, 63.41 ± 8.41) and overall quality of life (78%, 71.68 ± 5.94) as good. However, comparatively lower ratings in physical health (55%) suggests that physically demanding livelihood and work-related strain may influence physical wellbeing.

The chi-square analysis has further demonstrated that overall quality of life is significantly associated with the presence of diabetes mellitus and hypertension. Fisherwomen with these conditions have reported poorer quality of life compared to those without morbidity. However, the findings are primarily based on bivariate associations, which may not fully account for the potential influence of confounding variables such as age, body mass index and occupational characteristics, which may also influence quality of life of fisherwomen. As the number of comorbidities increased, quality of life has declined, with physical health domain being more affected than psychological health domain. These findings suggest multiple chronic health conditions may significantly influence perceived wellbeing among fisherwomen, highlighting the importance of preventive health services and targeted public health interventions among artisanal fisherwomen. Similar

observations have been reported in other fishing communities. Müller *et al.* (2016) have reported lower health-related quality of life among artisanal fisherwomen in Brazil, particularly those with musculoskeletal disorders, hypertension and other chronic health conditions. In addition, multimorbidity has been widely associated with reduced quality of life due to increased disease burden and functional limitations (Makovski *et al.*, 2019).

Limitations

The present study has certain limitations. First, the cross-sectional study design limits the ability to establish causal inferences between health indicators and wellbeing outcomes. Second, the self-reported medical history may introduce response and recall bias. Third, the use of percentile-based categorization for WHOQOL-BREF scores may limit direct comparability with studies. In addition, results in the present study are bivariate associations, therefore future studies adjusting confounding variables may be needed for causal relationships. Finally, as the present study is conducted among fisherwomen in selected coastal villages of Ramanathapuram District, the findings may not be fully generalizable to other fishing communities in India.

Conclusion

Artisanal fisherwomen are affected by several health challenges, including overweight, central obesity, diabetes and hypertension. Although perceived quality of life remains relatively positive, physical and environmental domains appear less favorable. Comorbidities are significantly associated with overall quality of life, emphasizing the importance of comprehensive health monitoring, multimorbidity assessment and focused public health policies. Interventions addressing nutritional status, cardiometabolic risk, occupational hazards and socioeconomic vulnerabilities may contribute to improve the wellbeing of this underprivileged workforce.

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Author Contributions

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Conceptualization, Methodology, Investigation, Data Collection, Data Analysis, Writing - Original Draft.

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Ethics Approval and Consent to Participate

The study has been approved by Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India (Approval No. AUW/XMT-038, FSMD/IHEC/23–24). Written informed consent was obtained from all participants prior to their inclusion in the study.

Declaration of Generative AI

The authors declare that no Generative AI tools were used in the preparation of this manuscript.

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