

# AI-Enabled Climate-Resilient Nursing Care: Impact on Maternal Psychological Well-Being, Family Health, and Chronic Disease Risk Reduction among Adults

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## ABSTRACT

### Background:

Climate change is increasingly recognized as a major determinant of maternal, family, and chronic disease health, particularly through extreme heat, environmental stressors, food and water insecurity, and disruptions in access to healthcare. Artificial intelligence (AI) offers a promising approach for identifying climate-related health vulnerabilities and supporting personalized, preventive nursing care. However, evidence regarding the integration of AI-supported climate-health risk assessment into nursing interventions remains limited.

### Aim:

This study aimed to evaluate the impact of an AI-enabled climate-resilient nursing care program on maternal psychological well-being, family health practices, and chronic disease risk reduction among adults.

### Methods:

A quasi-experimental one-group pretest–posttest design with a two-month follow-up was conducted

among a purposive sample of 100 mothers and their families attending the Family Planning, Women's Health, and Chronic Disease outpatient clinics of Sohag University Hospitals, Egypt. Participants were selected using a purposive sampling technique. The intervention was implemented over four weeks through two sessions per week. The program incorporated AI-supported climate-health risk assessment and risk stratification to identify individual and family vulnerabilities and guide personalized nurse-led interventions. Data were collected using a Sociodemographic, Clinical, and Climate-Exposure Data Sheet; the WHO-5 Well-Being Index; a Climate-Health Knowledge Questionnaire; a Family Climate-Resilient Health Practices Scale; a Chronic Disease Risk-Reduction Behavior Scale; and an AI-Supported Climate-Health Risk Profile. Outcomes were assessed at baseline, immediately after the intervention, and at two-month follow-up.

### Results:

The intervention is expected to demonstrate significant improvements in maternal psychological well-being, climate-health knowledge, family climate-resilient health practices, and chronic disease risk-reduction behaviors following program implementation, with beneficial effects maintained at the two-month follow-up. AI-supported risk stratification is expected to facilitate individualized nursing interventions according to maternal, family, environmental, and chronic disease risk profiles. Final statistical findings will be reported using appropriate paired comparisons, effect sizes, and 95% confidence intervals following completion of data analysis.

### Conclusion:

An AI-enabled climate-resilient nursing care program may provide an innovative, preventive, and personalized approach to strengthening maternal and family health while reducing modifiable chronic disease risks in the context of climate change. Integrating AI-assisted risk assessment with nurse-led education, behavioral support, and climate-adaptive health practices may enhance the capacity of nursing services to deliver proactive and resilient family-centered care.

**Keywords:** Artificial Intelligence; Climate-Resilient Nursing Care; Chronic Disease Risk Reduction; Family Health; Maternal Psychological Well-Being.

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### Introduction

Climate change has emerged as one of the most significant global threats to public health, affecting populations through extreme heat, floods, droughts, air pollution, water and food insecurity, and disruption of essential health services. These climate-related hazards can interact with social and environmental vulnerabilities, increasing exposure to illness and reducing the capacity of individuals and health systems to respond effectively. The World Health Organization (WHO) emphasizes that climate-resilient health systems should be capable of anticipating, preventing, preparing for, responding to, and recovering from climate-related shocks while

maintaining safe and equitable health services. Therefore, integrating climate-health risk assessment, early warning, prevention, and adaptation into routine health care has become an important priority for contemporary health systems (**World Health Organization, 2023**).

Climate change has particular implications for women and families because climate-related exposures can affect maternal health, psychological well-being, nutrition, water and sanitation, and access to health services. Extreme heat and other climate hazards have been associated with adverse maternal and perinatal outcomes, including hypertensive disorders, gestational diabetes, preterm birth, low birth weight, and stillbirth. In addition,

exposure to climate-related hazards and their consequences may increase psychological stress, anxiety, and depressive symptoms among women. Families may also experience increased vulnerability when climate-related disruptions affect food security, safe water, household living conditions, and access to preventive and curative health care. Consequently, maternal and family health services need to adopt preventive and climate-adaptive approaches that address both immediate health threats and longer-term psychosocial and behavioral consequences **(World Health Organization, 2023)**.

Climate-related environmental changes may also intensify the burden of chronic diseases and increase the importance of preventive health behaviors. Extreme heat, for example, can exacerbate cardiovascular disease, diabetes, respiratory conditions, and mental health problems, while climate-related disruptions may negatively influence physical activity, nutrition, medication adherence, and access to routine health services. The WHO therefore identifies cardiovascular and respiratory diseases, mental health, maternal and newborn health, nutrition, and other climate-sensitive conditions as important areas for climate-informed health programming. From a preventive perspective, strengthening healthy dietary practices, physical activity, weight management, chronic disease self-management, emergency preparedness, and timely health-care seeking may improve individual and family capacity to cope with climate-related health risks **(Jacobsen et al., 2022)**.

Nurses are strategically positioned to translate climate-health evidence into practical, individualized, and family-centered interventions because of their continuous contact with individuals, families, and communities. Climate-resilient nursing care can include assessment of climate-related vulnerabilities, health education, early identification of risk, preventive counseling, behavioral modification, emergency preparedness, and linkage with appropriate health services. The WHO highlights the importance of developing a climate-smart health workforce with competencies in identifying, preventing, and managing climate-related health risks. At the same time, advances in artificial intelligence (AI) provide opportunities to support risk assessment and individualized decision-making by integrating multiple clinical, behavioral, environmental, and sociodemographic indicators. When appropriately implemented, AI can function as

a clinical decision-support approach that helps nurses identify higher-risk individuals and tailor preventive interventions rather than replacing professional nursing judgment **(Salvador Costa et al., 2025)**.

Despite increasing recognition of the health consequences of climate change and the potential of digital technologies to strengthen preventive care, there remains a need for applied nursing research that integrates AI-supported climate-health risk assessment with comprehensive maternal and family health interventions. Existing climate-resilience frameworks emphasize vulnerability assessment, integrated risk monitoring, climate-informed health programs, and workforce capacity building, but evidence on how these components can be operationalized through nurse-led, personalized interventions remains limited (World Health Organization, 2022). Therefore, the present study was designed to evaluate an AI-enabled climate-resilient nursing care program aimed at identifying maternal and family climate-health vulnerabilities and translating these risks into individualized nursing education and behavioral interventions. The study focuses on maternal psychological well-being, family climate-resilient health practices, and chronic disease risk-reduction behaviors among adult, thereby addressing an important intersection between climate change, digital health innovation, preventive nursing, and family health **(Li et al., 2025)**.

Nurses play a central role in translating climate-health risk information into practical, individualized, and family-centered care. Within an AI-enabled climate-resilient nursing model, the nurse remains responsible for comprehensive assessment, interpretation of AI-supported risk profiles, clinical judgment, individualized care planning, implementation of preventive interventions, and continuous evaluation of outcomes. The nurse can assess maternal and family exposure to extreme heat, air pollution, water and food insecurity, inadequate housing conditions, and barriers to health-care access, while also identifying modifiable behavioral and chronic disease risk factors. Based on the AI-supported risk stratification, the nurse provides tailored education and counseling regarding heat protection, hydration and nutrition, physical activity, weight management, chronic disease prevention and self-management, psychological coping, emergency preparedness, and appropriate health-care seeking **(World Health Organization, 2024)**. Importantly, AI

is used as a decision-support and personalization tool rather than as a replacement for professional nursing judgment. Through ongoing communication, behavioral support, monitoring, and follow-up, the nurse helps mothers and families transform climate-health risk information into sustainable protective practices and strengthens their capacity to adapt to climate-related health challenges (Portela Dos Santos et al., 2024).

### Significance of the Study

The significance of the present study lies in its innovative integration of artificial intelligence, climate-resilient health care, and nurse-led preventive practice to address the interconnected challenges of maternal psychological well-being, family health resilience, and chronic disease risk in the context of climate change. By combining AI-supported climate-health risk stratification with individualized nursing assessment, education, behavioral counseling, and follow-up, the proposed approach shifts conventional nursing care from a predominantly reactive model toward a proactive, risk-informed, and personalized model of prevention. This approach positions nurses as key agents in translating complex climate-health and AI-generated risk information into clinically meaningful and culturally appropriate interventions while preserving professional nursing judgment and accountability. Furthermore, targeting mothers and their families may extend the benefits of preventive nursing beyond the individual to the household level, potentially strengthening adaptive health behaviors, psychological resilience, emergency preparedness, and chronic disease risk reduction. Accordingly, the study may contribute novel evidence for the integration of AI-assisted decision support into climate-resilient nursing practice and provide a potentially scalable framework for strengthening preventive, family-centered, and sustainable health services in settings increasingly affected by climate-related health risks.

### Aim:

This study aimed to evaluate the impact of an AI-enabled climate-resilient nursing care program on maternal psychological well-being, family health practices, and chronic disease risk-reduction among adult.

### Research Hypotheses

**H1:** Mothers who receive the AI-enabled climate-resilient nursing care program will demonstrate a statistically significant improvement in maternal psychological well-being, as measured by the WHO-5 Well-Being Index, compared with their baseline assessment.

**H2:** Mothers who receive the AI-enabled climate-resilient nursing care program will demonstrate a statistically significant improvement in climate-health knowledge following the intervention compared with baseline.

**H3:** Mothers and their families who receive the AI-enabled climate-resilient nursing care program will demonstrate a statistically significant improvement in family climate-resilient health practices following the intervention compared with baseline.

**H4:** Mothers and their families who receive the AI-enabled climate-resilient nursing care program will demonstrate a statistically significant improvement in chronic disease risk-reduction behaviors among adult following the intervention compared with baseline.

## Subjects and Methods

### Research Design

A quasi-experimental one-group pretest–posttest design with a two-month follow-up was adopted to evaluate the effectiveness of an AI-enabled climate-resilient nursing care program on maternal psychological well-being, family climate-resilient health practices, and chronic disease risk-reduction behaviors. Participants were assessed at three time points: baseline assessment before program implementation (T0), immediately after completion of the four-week intervention (T1), and two months after the intervention (T2).

### Study Setting

The study was conducted at the Family Planning, Women's Health, and Chronic Disease outpatient clinics of Sohag University Hospitals, Egypt. These clinics were selected because they provide regular preventive and follow-up services to women and families and offer an appropriate setting for integrating climate-health assessment, health education,

behavioral counseling, chronic disease prevention, and family-centered nursing care.

### Subjects

The study subjects consisted of 100 mothers and their families who attended the selected outpatient clinics during the study period. A purposive sampling technique was used to recruit participants who met the predetermined eligibility criteria and were able to participate in the complete intervention and follow-up assessments. The sample included mothers who were responsible for actively involved in household health-related decisions and who had identifiable climate-health exposures, modifiable lifestyle risks, or potential vulnerability to climate-related health effects.

### Inclusion Criteria

Participants were eligible for inclusion if they were mothers aged 18 years or older, had regular contact with the selected outpatient services, were able to communicate and participate in the educational sessions, had access to a mobile phone or other digital communication device when required for the intervention, and agreed to participate in the study and complete the follow-up assessment.

### Exclusion Criteria

Mothers were excluded if they had severe cognitive or communication difficulties that interfered with participation, were unable to complete the intervention sessions, or were simultaneously participating in another structured health-behavior intervention that could substantially influence the study outcomes.

### Sample Size Calculation

The required sample size was estimated using G\*Power software (version 3.1.9.7) for a paired-samples t-test, considering a two-tailed significance level of  $\alpha = 0.05$ , statistical power of 80% ( $1 - \beta = 0.80$ ), and an anticipated medium effect size (Cohen's  $d \approx 0.30$ – $0.35$ ) based on the expected improvement in mothers' climate-health knowledge and practices following the intervention. The calculation yielded an estimated sample of approximately 84–90 participants. To compensate for possible non-response, withdrawal, and loss to follow-up, approximately 10–15% was added.

Accordingly, the final target sample was increased to 100 mothers and their families.

### Research tools:

**Tool I: Sociodemographic, Clinical, and Climate-Exposure Data Sheet:** A structured researcher-developed data sheet was used to collect participants' sociodemographic, clinical, and climate-exposure characteristics. It included three parts: maternal sociodemographic characteristics such as age, residence, marital status, educational level, occupation, family size, and monthly family income; clinical characteristics including weight, height, body mass index, waist circumference, blood pressure, history and family history of chronic diseases, current medications, and physical activity; and climate-exposure characteristics including exposure to extreme heat, water and food insecurity, housing ventilation, air-pollution exposure, access to cooling facilities, previous climate-related symptoms, and access to health-care services during extreme weather events. The tool was used primarily for descriptive analysis and for identifying individual climate-health risk factors that could inform the AI-supported risk stratification process.

**Tool II: WHO-5 Well-Being Index:** Maternal psychological well-being was assessed using the World Health Organization Five Well-Being Index (WHO-5). The instrument consists of five positively worded items assessing subjective psychological well-being during the previous two weeks. Each item is rated on a six-point scale ranging from 0 = "At no time" to 5 = "All of the time." The raw total score ranges from 0 to 25 and is multiplied by four to obtain a standardized percentage score ranging from 0 to 100, with higher scores indicating better psychological well-being. For the present study, a score of  $\leq 50$  was considered indicative of poor psychological well-being, whereas a score  $> 50$  indicated good psychological well-being. The WHO-5 has been extensively used internationally as a brief measure of subjective psychological well-being (World Health Organization Regional Office for Europe, 1998; Topp et al., 2015).

**Tool III: Climate-Health Knowledge Questionnaire:** This tool was designed by researcher after extensive literature review (Amin et al., 2023; Eltelt et al., 2023), A 25-item researcher-developed questionnaire was

used to assess mothers' knowledge regarding climate change and its potential effects on maternal, family, and chronic health. The questionnaire covered five domains: climate change and health, maternal health, family health, chronic disease risks, and climate-resilient preventive measures, with five items allocated to each domain. Each item had one correct response and was scored as 1 for a correct answer and 0 for an incorrect or "don't know" response. The total score ranged from 0 to 25. Knowledge levels were classified as poor (<50%), fair (50–<75%), and good ( $\geq 75\%$ ). The questionnaire was developed based on current climate-health and climate-resilience recommendations and was subjected to expert review for content validity and pilot testing before the main study.

**Tool IV: Family Climate-Resilient Health Practices Scale:** A 30-item researcher-developed scale. It was developed by researcher after extensive literature review (Crandall et al., 2020), was used to assess family practices related to climate adaptation, health promotion, and prevention of climate-related health problems. The scale consisted of five domains: heat and extreme-weather protection, water/food and environmental safety, healthy nutrition and physical activity, family preventive health practices, and emergency preparedness and appropriate health-care seeking, with six items in each domain. Responses were rated on a four-point Likert scale: 0 = never, 1 = rarely, 2 = sometimes, and 3 = always. The total score ranged from 0 to 90, with higher scores indicating better family climate-resilient health practices. A percentage score of <60% was considered unsatisfactory, whereas  $\geq 60\%$  was considered satisfactory. Content validity, pilot testing, and internal consistency reliability were established before implementation.

**Tool V: Chronic Disease Risk-Reduction Behavior Scale:** It was developed by researcher after extensive literature review (Gillespie, & Lenz, 2011). A 25-item researcher-developed scale was used to assess behaviors associated with reducing modifiable chronic disease risks. The scale comprised five domains: healthy dietary behaviors, physical activity, weight-management practices, cardiometabolic prevention, and climate-adapted chronic disease self-management, with five items in each domain. Each item was rated using a four-point Likert scale ranging from 0 = never to 3 = always. The total score ranged from 0 to 75, with higher scores reflecting stronger chronic disease risk-reduction

behaviors. Scores below 60% were categorized as poor risk-reduction behavior, whereas scores of 60% or higher were considered satisfactory. The scale underwent expert evaluation, pilot testing, and reliability assessment before use in the main study.

**Tool VI: AI-Supported Climate-Health Risk Profile:** It was developed by researcher after extensive literature review (Quadri et al., 2026). An AI-supported risk stratification profile was developed to identify individual and family vulnerability to climate-related health risks and to support personalization of the nursing intervention. The profile incorporated maternal characteristics, climate-exposure factors, family vulnerability indicators, and modifiable chronic disease risk factors, including body mass index, waist circumference, blood pressure, physical inactivity, dietary risk, family history of chronic disease, heat exposure, water insecurity, air-pollution exposure, housing vulnerability, psychological vulnerability, and access to health-care services. Based on the integrated risk indicators, participants were categorized into low-, moderate-, or high-risk profiles. The AI-generated risk profile was used to guide individualized nursing education, climate-adaptive recommendations, psychological support, lifestyle modification, and chronic disease risk-reduction strategies. The AI system functioned as a clinical decision-support and personalization tool rather than as an independent diagnostic system, with final assessment and nursing decisions remaining under the responsibility of the nurse.

#### **Validity:**

The validity of the researcher-developed instruments, including the Sociodemographic, Clinical, and Climate-Exposure Data Sheet, Climate-Health Knowledge Questionnaire, Family Climate-Resilient Health Practices Scale, Chronic Disease Risk-Reduction Behavior Scale, and AI-Supported Climate-Health Risk Profile, were established through content and face validity. The instruments were submitted to a panel of **five experts** in Community Health Nursing, Maternal and Women's Health Nursing, Medical-Surgical Nursing, Public Health, and Psychiatric Nursing. The experts were evaluate the instruments for relevance, clarity, comprehensiveness, appropriateness of wording, and suitability for achieving the study objectives. Necessary modifications were made according to their recommendations. The WHO-5 Well-Being

Index is a standardized and previously validated instrument and was used without modification except for appropriate translation and cultural adaptation if required.

#### **Reliability:**

The reliability of the researcher-developed instruments was assessed to determine their internal consistency and stability. Internal consistency was evaluated using **Cronbach's alpha coefficient** for the multi-item scales, including the Climate-Health Knowledge Questionnaire, Family Climate-Resilient Health Practices Scale, and Chronic Disease Risk-Reduction Behavior Scale. A Cronbach's alpha coefficient of  $\geq 0.70$  was considered acceptable for research purposes. For the knowledge questionnaire, additional assessment of item performance may be conducted to ensure that the items adequately discriminate between different levels of knowledge. The reliability of the WHO-5 was assessed in the study sample to confirm its internal consistency in the local context.

#### **Pilot Study:**

A pilot study was conducted on 10% of the total study sample (10 mothers) before commencing the main study. The pilot participants were selected according to the same inclusion and exclusion criteria as the main study but was not included in the final study sample to avoid possible contamination or duplication of responses. The pilot study was conducted to assess the clarity, comprehensibility, sequence, applicability, and estimated time required to complete the study instruments, as well as the feasibility and acceptability of the AI-supported risk assessment and nursing intervention procedures. The findings of the pilot study was used to identify any ambiguities, technical difficulties, or modifications required in the instruments and intervention procedures. If substantial modifications are required, the revised instruments were undergo further expert review before implementation in the main study.

#### **Ethical Considerations**

The study was conducted after obtaining approval from the Research Ethics Committee of the Faculty of Nursing, Sohag University, as well as official permission from the relevant authorities at Sohag University Hospitals. Written informed consent was obtained from every eligible mother after providing a clear explanation of the study purpose, procedures,

potential benefits, and the voluntary nature of participation. Participants were informed that they had the right to refuse participation or withdraw from the study at any time without affecting the health services they received. Confidentiality and privacy were maintained throughout the study by using identification codes instead of participants' names and restricting access to the collected data to the research team. All collected information was used exclusively for scientific purposes. The AI-supported component functioned solely as a clinical decision-support and risk-stratification tool and did not independently diagnose disease or replace professional nursing judgment. Final assessment, interpretation, individualized intervention, and clinical decisions remained the responsibility of the nurse/researcher. Participants identified as having clinically important psychological, chronic disease, or climate-related health concerns were appropriately referred to the relevant healthcare professionals according to the hospital referral system.

#### **Phases of the Intervention**

The intervention was implemented over four consecutive weeks, with two sessions per week, resulting in a total of eight structured sessions. The intervention followed a sequential, nurse-led model consisting of four main phases: baseline assessment and AI-supported risk stratification, personalized nursing intervention, maternal psychological and family health resilience enhancement, and consolidation, evaluation, and follow-up.

##### **Phase I: Baseline Assessment and AI-Supported Risk Stratification**

This phase was conducted before initiating the intervention. The researcher/nurse obtained informed consent and collected baseline information regarding the mothers' sociodemographic characteristics, clinical status, lifestyle behaviors, family health characteristics, and climate-related environmental exposures. Baseline maternal psychological well-being, climate-health knowledge, family climate-resilient practices, and chronic disease risk-reduction behaviors were also assessed using the study instruments.

The collected information was then entered into the **AI-Supported Climate-Health Risk Profile**, which assisted in identifying individual and family vulnerabilities and categorizing participants into **low-, moderate-,**

**or high-risk profiles.** The AI-generated profile was used to support individualized nursing care planning; however, the nurse independently reviewed and interpreted the information and retained full responsibility for clinical decision-making.

## Phase II: Personalized Climate-Resilient Nursing Intervention

During the second phase, the nurse developed an individualized intervention plan according to each participant's identified needs and risk profile. The intervention addressed climate-health knowledge, recognition of climate-related health risks, protection from extreme heat and weather events, adequate hydration, food and water safety, environmental health, healthy nutrition, physical activity, weight management, and prevention of cardiometabolic risk factors.

Participants with existing chronic disease risks received individualized education regarding symptom monitoring, medication adherence, lifestyle modification, prevention of exacerbations, and appropriate healthcare-seeking behavior during climate-related events.

## Phase III: Maternal Psychological and Family Health Resilience Enhancement

This phase focused on strengthening maternal psychological well-being and the capacity of mothers and their families to adapt to climate-related health challenges. The nurse provided supportive counseling and practical strategies for stress management, emotional regulation, coping with climate-related concerns,

### Recommended session structure

| Session | Main focus                          | Core activities                                                    |
|---------|-------------------------------------|--------------------------------------------------------------------|
| 1       | Baseline & AI health risk profiling | Assessment, climate-health risks, AI-supported risk stratification |
| 2       | Climate-health knowledge            | Climate change, maternal/family health, warning signs              |
| 3       | Heat & environmental protection     | Heat protection, hydration, air pollution, water/food safety       |
| 4       | Healthy lifestyle                   | Nutrition, physical activity, weight management                    |

### Statistical Analysis

maintaining healthy family routines, and strengthening family support.

Mothers were also trained to develop family-level protective behaviors, including heat preparedness, safe food and water practices, emergency preparedness, recognition of warning signs, appropriate healthcare-seeking behavior, and protection of vulnerable family members during extreme environmental conditions. **Interactive discussions, demonstrations, problem-solving activities, and individualized counseling** were used to promote active participation and facilitate the application of acquired knowledge and skills.

## Phase IV: Consolidation, Evaluation, and Follow-Up

The final phase emphasized reinforcement of acquired knowledge and behaviors and evaluation of the intervention outcomes. At the end of the four-week intervention, participants received reinforcement regarding key climate-resilient practices, psychological coping strategies, healthy lifestyle behaviors, and chronic disease risk reduction.

The post-intervention assessment was then conducted using the same outcome measures applied at baseline. A **two-month follow-up assessment** was subsequently performed to determine the sustainability of changes in maternal psychological well-being, climate-health knowledge, family climate-resilient practices, and chronic disease risk-reduction behaviors. Participants who required additional support or demonstrated persistent health risks received appropriate nursing guidance and referral according to their identified needs.

| Session | Main focus                        | Core activities                                                  |
|---------|-----------------------------------|------------------------------------------------------------------|
| 5       | Chronic disease risk reduction    | BP, diabetes/cardiovascular risk, self-management                |
| 6       | Maternal psychological well-being | Stress management, coping, emotional resilience                  |
| 7       | Family climate resilience         | Family preparedness, vulnerable members, emergency response      |
| 8       | Integration & evaluation          | Individual action plan, reinforcement, post-test, follow-up plan |

The collected data were coded, entered, tabulated, and statistically analyzed using **IBM**

**SPSS Statistics** software. Descriptive statistics, including frequencies and percentages for categorical variables and means and standard deviations for continuous variables, were used to summarize the study variables. The normality of continuous data was assessed using the **Shapiro–Wilk test**. Changes in maternal psychological well-being, climate-health knowledge, family climate-resilient health practices, and chronic disease risk-reduction behaviors across baseline (T0), immediately after the intervention (T1), and two-month follow-up (T2) were analyzed using **Repeated Measures ANOVA** for normally distributed continuous variables, with the Greenhouse–Geisser correction applied when the assumption of sphericity was violated, followed by Bonferroni-adjusted pairwise comparisons when significant differences were detected. For non-normally distributed continuous variables, the **Friedman test** was used. Changes in categorical outcomes across the three

assessment points were analyzed using **Cochran’s Q test**, followed by McNemar tests for significant pairwise comparisons. Pearson or Spearman correlation coefficients were used, as appropriate, to examine relationships between study variables, while Chi-square or Fisher’s exact tests were used to assess associations between categorical variables. Multiple linear regression analysis was performed, where appropriate, to identify independent predictors of post-intervention and follow-up outcome scores. AI-supported climate-health risk categories were summarized using frequencies and percentages and were examined in relation to selected maternal, clinical, family, behavioral, and climate-exposure characteristics. Effect sizes and **95% confidence intervals** were reported to determine the magnitude and precision of the intervention effects. A **p-value < 0.05** was considered statistically significant, while **p < 0.001** was considered highly statistically significant.

#### Results:

**Table (1): Distribution of the Studied Mothers According to Their Sociodemographic Characteristics (N = 100)**

| Sociodemographic characteristics | No. | %    |
|----------------------------------|-----|------|
| <b>Age (years)</b>               |     |      |
| 18–<25                           | 24  | 24.0 |
| 25–<35                           | 46  | 46.0 |
| ≥35                              | 30  | 30.0 |
| <b>Residence</b>                 |     |      |
| Rural                            | 61  | 61.0 |
| Urban                            | 39  | 39.0 |
| <b>Educational level</b>         |     |      |
| Illiterate/read and write        | 17  | 17.0 |
| Basic/secondary education        | 48  | 48.0 |
| University education             | 35  | 35.0 |

Table (1) shows that nearly half of the studied mothers (46.0%) were aged 25–<35 years, while 30.0% were aged ≥35 years. More than three-fifths of the mothers (61.0%) lived in rural areas. Regarding education, 48.0% had basic or secondary education, compared with 35.0% who had university education. The

**Table (2): Distribution of the Studied Mothers According to Clinical, Behavioral, and Climate-Exposure Characteristics (N = 100)**

| Characteristics | No. | % |
|-----------------|-----|---|
|-----------------|-----|---|

| Sociodemographic characteristics | No. | %    |
|----------------------------------|-----|------|
| <b>Occupation</b>                |     |      |
| Housewife                        | 72  | 72.0 |
| Working                          | 28  | 28.0 |
| <b>Family size</b>               |     |      |
| ≤3 members                       | 21  | 21.0 |
| 4–5 members                      | 54  | 54.0 |
| >5 members                       | 25  | 25.0 |
| <b>Monthly family income</b>     |     |      |
| Insufficient                     | 58  | 58.0 |
| Sufficient                       | 42  | 42.0 |
| <b>Health insurance coverage</b> |     |      |
| Yes                              | 37  | 37.0 |
| No                               | 63  | 63.0 |

majority of mothers (72.0%) were housewives, and more than half (54.0%) belonged to families consisting of 4–5 members. More than half of the studied families (58.0%) reported insufficient monthly income, while only 37.0% had health insurance coverage.

| Characteristics                        | No. | %    |
|----------------------------------------|-----|------|
| <b>BMI</b>                             |     |      |
| Normal (<25 kg/m <sup>2</sup> )        | 29  | 29.0 |
| Overweight (25–<30 kg/m <sup>2</sup> ) | 43  | 43.0 |
| Obese (≥30 kg/m <sup>2</sup> )         | 28  | 28.0 |

| Characteristics                          | No. | %    |
|------------------------------------------|-----|------|
| <b>Elevated blood pressure</b>           |     |      |
| No                                       | 67  | 67.0 |
| Yes                                      | 33  | 33.0 |
| <b>Family history of chronic disease</b> |     |      |
| No                                       | 38  | 38.0 |
| Yes                                      | 62  | 62.0 |
| <b>Physically inactive</b>               |     |      |
| No                                       | 36  | 36.0 |
| Yes                                      | 64  | 64.0 |
| <b>Frequent exposure to extreme heat</b> |     |      |
| No                                       | 31  | 31.0 |
| Yes                                      | 69  | 69.0 |

| Characteristics                                                              | No. | %    |
|------------------------------------------------------------------------------|-----|------|
| <b>Inadequate home ventilation</b>                                           |     |      |
| No                                                                           | 44  | 44.0 |
| Yes                                                                          | 56  | 56.0 |
| <b>Limited access to cooling facilities</b>                                  |     |      |
| No                                                                           | 52  | 52.0 |
| Yes                                                                          | 48  | 48.0 |
| <b>Previous climate-related health symptoms</b>                              |     |      |
| No                                                                           | 42  | 42.0 |
| Yes                                                                          | 58  | 58.0 |
| <b>Perceived difficulty accessing health services during extreme weather</b> |     |      |
| No                                                                           | 47  | 47.0 |

Table (2) demonstrates that overweight was the most common BMI category (43.0%), followed by obesity (28.0%). Almost two-thirds of mothers (62.0%) reported a family history of chronic disease, while 64.0% were

physically inactive. Climate-related vulnerability was also evident, as 69.0% reported frequent exposure to extreme heat, 56.0% reported inadequate home ventilation, and 58.0% had previously experienced climate-related health symptoms. More than half (53.0%) reported difficulty accessing health services during extreme weather.

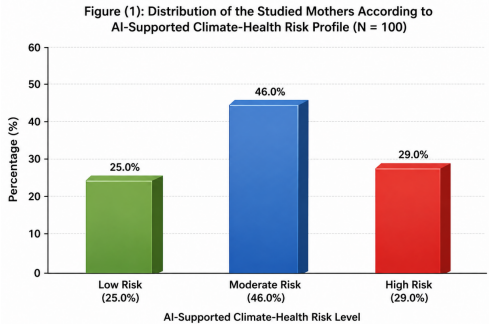


Figure (1): indicates that nearly half of the studied mothers (46.0%) were classified as having a moderate climate-health risk, while 29.0% were classified as high risk and only 25.0% as low risk. The predominance of moderate and high-risk profiles highlights the potential value of AI-supported risk stratification in identifying mothers who may

**Table (3): Changes in Maternal Psychological Well-Being, Climate-Health Knowledge, Family Climate-Resilient Practices, and Chronic Disease Risk-Reduction Behaviors Across the Three Assessment Points**

require more intensive and individualized nursing interventions. The AI-generated classification should be interpreted as a clinical decision-support profile rather than an independent diagnosis, with final risk interpretation and intervention decisions remaining under the responsibility of the nurse.

| Study outcomes                         | Baseline (T0) Mean $\pm$ SD | Post-intervention (T1) Mean $\pm$ SD | Follow-up (T2) Mean $\pm$ SD | F      | p-value |
|----------------------------------------|-----------------------------|--------------------------------------|------------------------------|--------|---------|
| WHO-5 psychological well-being (0–100) | 48.6 $\pm$ 9.4              | 68.9 $\pm$ 8.1                       | 64.7 $\pm$ 8.7               | 156.42 | <0.001* |

| Study outcomes                                  | Baseline (T0)<br>Mean<br>± SD | Post-intervention (T1)<br>Mean ± SD | Follow-up (T2)<br>Mean ± SD | F      | p-value |
|-------------------------------------------------|-------------------------------|-------------------------------------|-----------------------------|--------|---------|
| Climate-health knowledge (0–25)                 | 11.2 ± 3.5                    | 20.4 ± 2.1                          | 18.7 ± 2.6                  | 248.31 | <0.001* |
| Family climate-resilient practices (0–90)       | 46.8 ± 10.2                   | 72.6 ± 8.4                          | 68.9 ± 9.1                  | 182.64 | <0.001* |
| Chronic disease risk-reduction behaviors (0–75) | 38.7 ± 9.1                    | 61.8 ± 7.6                          | 57.4 ± 8.2                  | 169.37 | <0.001* |

Table (3) reveals statistically significant improvements in all major study outcomes across the three assessment points. Maternal psychological well-being increased from a baseline mean of  $48.6 \pm 9.4$  to  $68.9 \pm 8.1$  immediately after the intervention, with a slight decline to  $64.7 \pm 8.7$  at the two-month follow-up while remaining substantially higher than baseline. Similarly, climate-health knowledge increased markedly from  $11.2 \pm 3.5$  at baseline to  $20.4 \pm 2.1$  post-intervention and remained improved at follow-up. Family climate-resilient health practices and chronic disease risk-reduction behaviors demonstrated comparable patterns.

**Table (4): Pairwise Comparisons of Study Outcomes Between Assessment Points**

| Outcome                            | T0 vs. T1<br>Mean Difference | p-value | T1 vs. T2<br>Mean Difference | p-value | T0 vs. T2<br>Mean Difference | p-value |
|------------------------------------|------------------------------|---------|------------------------------|---------|------------------------------|---------|
| WHO-5 psychological well-being     | 20.3                         | <0.001* | 4.2                          | <0.001* | 16.1                         | <0.001* |
| Climate-health knowledge           | 9.2                          | <0.001* | 1.7                          | <0.001* | 7.5                          | <0.001* |
| Family climate-resilient practices | 25.8                         | <0.001* | 3.7                          | <0.001* | 22.1                         | <0.001* |

Table (4) demonstrates statistically significant differences in all study outcomes across the three assessment points. WHO-5 psychological well-being showed a substantial improvement from T0 to T1 (mean difference = 20.3), with a further improvement of 4.2 points from T1 to T2, resulting in an overall improvement of 16.1 points between T0 and T2 ( $p < 0.001$ ). Climate-health knowledge increased by 9.2 points from T0 to T1 and remained significantly improved at follow-up, with a further increase of 1.7 points from T1 to T2 and an overall difference of 7.5 points between T0 and T2 ( $p < 0.001$ ). Family climate-resilient practices demonstrated the greatest

| Study outcomes                          | Baseline (T0)<br>Mean<br>± SD | Post-intervention (T1)<br>Mean ± SD | Follow-up (T2)<br>Mean ± SD | F  | p-value |
|-----------------------------------------|-------------------------------|-------------------------------------|-----------------------------|----|---------|
| disease risk-reduction behaviors (0–75) | 9.1                           | 7.6                                 | ± 8.2                       | 37 | 1*      |

\*Statistically significant at  $p < 0.05$ . Repeated Measures ANOVA.

than baseline. Similarly, climate-health knowledge increased markedly from  $11.2 \pm 3.5$  at baseline to  $20.4 \pm 2.1$  post-intervention and remained improved at follow-up. Family climate-resilient health practices and chronic disease risk-reduction behaviors demonstrated comparable patterns.

| Outcome                                  | T0 vs. T1<br>Mean Difference | p-value | T1 vs. T2<br>Mean Difference | p-value | T0 vs. T2<br>Mean Difference | p-value |
|------------------------------------------|------------------------------|---------|------------------------------|---------|------------------------------|---------|
| resilient practices                      |                              |         |                              |         |                              |         |
| Chronic disease risk-reduction behaviors | 23.1                         | <0.001* | 4.4                          | <0.001* | 18.7                         | <0.001* |

\*Bonferroni-adjusted pairwise comparison.

improvement, increasing by 25.8 points from T0 to T1 and by an additional 3.7 points from T1 to T2, with an overall improvement of 22.1 points from T0 to T2 ( $p < 0.001$ ). Similarly, chronic disease risk-reduction behaviors improved significantly, with mean differences of 23.1 points between T0 and T1, 4.4 points between T1 and T2, and 18.7 points between T0 and T2 ( $p < 0.001$ ). Overall, these findings indicate that the intervention produced significant immediate improvements across all outcomes, with most of the gains maintained or further enhanced at the two-month follow-up.

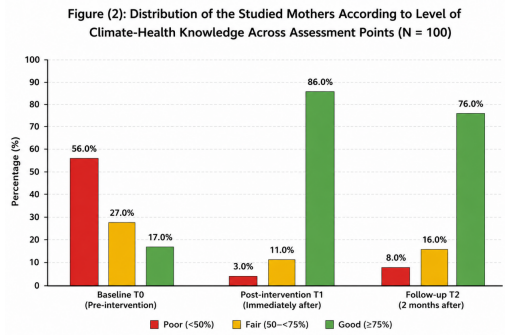


Figure (2) shows a pronounced improvement in climate-health knowledge following the intervention. The proportion of mothers with good knowledge increased from only 17.0% at baseline to 86.0% immediately after the intervention and remained high at 76.0% at two-month follow-up. Conversely, poor knowledge decreased from 56.0% to 3.0%

post-intervention and slightly increased to 8.0% at follow-up. Cochran's Q test confirmed a highly significant difference across the three assessment points ( $p < 0.001$ ), demonstrating strong and sustained improvement in mothers' understanding of climate-related health risks and preventive strategies.

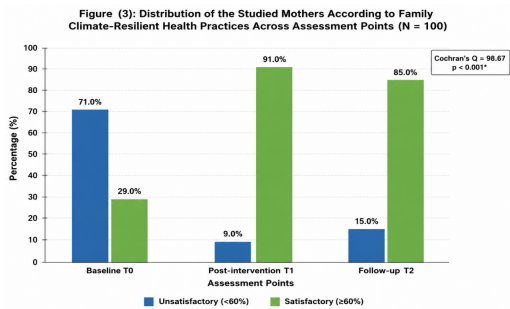


Figure (3) demonstrates a substantial improvement in family climate-resilient health practices following implementation of the intervention. The proportion of mothers demonstrating satisfactory practices increased from 29.0% at baseline to 91.0% immediately after the intervention. At two-month follow-up, 85.0% continued to demonstrate satisfactory

practices. The reduction in satisfactory practice from 91.0% to 85.0% suggests a small decline over time; however, performance remained considerably higher than baseline. The highly significant Cochran's Q result ( $p < 0.001$ ) indicates that the observed changes across the three assessment points were statistically significant.

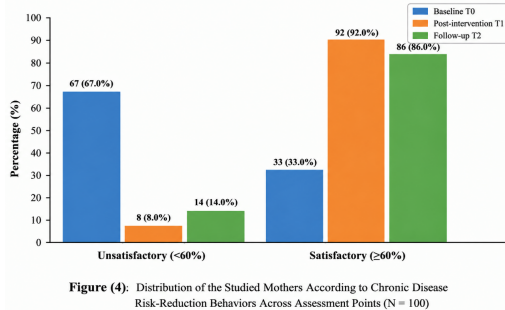


figure (4) indicates a marked improvement in chronic disease risk-reduction behaviors. At baseline, only 33.0% of mothers demonstrated satisfactory behaviors, compared with 92.0% immediately after the intervention. At follow-up, the proportion remained high at 86.0%. The significant Cochran's Q value ( $p < 0.001$ )

confirms statistically significant changes across the three assessment periods. These findings suggest that the intervention may have effectively promoted healthier dietary practices, physical activity, weight management, cardiometabolic prevention, and climate-adapted chronic disease self-management.

**Table (5): Relationship Between AI-Supported Climate-Health Risk Level and Selected Baseline Study Outcomes (N = 100)**

| Baseline variables             | Low risk Mean $\pm$ SD | Moderate risk Mean $\pm$ SD | High risk Mean $\pm$ SD | F     | p-value |
|--------------------------------|------------------------|-----------------------------|-------------------------|-------|---------|
| WHO-5 psychological well-being | 56.8 $\pm$ 7.2         | 49.1 $\pm$ 8.1              | 41.7 $\pm$ 8.4          | 28.64 | <0.001* |
| Climate-health knowledge       | 13.8 $\pm$ 3.1         | 11.2 $\pm$ 3.2              | 8.9 $\pm$ 3.0           | 21.37 | <0.001* |

Table (5) shows statistically significant differences in all baseline study outcomes according to the AI-supported climate-health risk level. Mothers classified as low risk had the highest mean scores for WHO-5 psychological well-being (56.8  $\pm$  7.2), climate-health knowledge (13.8  $\pm$  3.1), family climate-resilient practices (55.4  $\pm$  8.9), and chronic disease risk-reduction behaviors (46.2  $\pm$  7.8). In contrast, the high-risk group had the lowest mean scores across all outcomes, while the moderate-risk group showed intermediate values. The differences among the three risk

**Table (6): Correlations Between Maternal Psychological Well-Being, Climate-Health Knowledge, Family Climate-Resilient Practices, and Chronic Disease Risk-Reduction Behaviors at Post-Intervention Assessment (N = 100)**

| Variable                 | WHO-5 well-being | Climate-health knowledge | Family climate-resilient practices | Chronic disease risk-reduction behaviors |
|--------------------------|------------------|--------------------------|------------------------------------|------------------------------------------|
| WHO-5 well-being         | 1.000            | 0.512**                  | 0.586**                            | 0.624**                                  |
| Climate-health knowledge | 0.512*           | 1.000                    | 0.641**                            | 0.573**                                  |

Table (6) demonstrates significant positive correlations among the major study outcomes. Psychological well-being was moderately positively correlated with climate-health knowledge (r = 0.512), family climate-resilient practices (r = 0.586), and chronic disease risk-

| Baseline variables                       | Low risk Mean $\pm$ SD | Moderate risk Mean $\pm$ SD | High risk Mean $\pm$ SD | F     | p-value |
|------------------------------------------|------------------------|-----------------------------|-------------------------|-------|---------|
| Family climate-resilient practices       | 55.4 $\pm$ 8.9         | 46.7 $\pm$ 9.2              | 39.2 $\pm$ 8.7          | 31.42 | <0.001* |
| Chronic disease risk-reduction behaviors | 46.2 $\pm$ 7.8         | 38.4 $\pm$ 8.3              | 32.1 $\pm$ 7.9          | 27.81 | <0.001* |

\*Statistically significant at p < 0.05.

groups were statistically significant for WHO-5 psychological well-being (F = 28.64, p < 0.001), climate-health knowledge (F = 21.37, p < 0.001), family climate-resilient practices (F = 31.42, p < 0.001), and chronic disease risk-reduction behaviors (F = 27.81, p < 0.001). Overall, the findings indicate that higher AI-supported climate-health risk was associated with poorer baseline psychological well-being, lower climate-health knowledge, weaker family climate-resilient practices, and less satisfactory chronic disease risk-reduction behaviors.

| Variable                                 | WHO-5 well-being | Climate-health knowledge | Family climate-resilient practices | Chronic disease risk-reduction behaviors |
|------------------------------------------|------------------|--------------------------|------------------------------------|------------------------------------------|
| Family climate-resilient practices       | 0.586*           | 0.641**                  | 1.000                              | 0.688**                                  |
| Chronic disease risk-reduction behaviors | 0.624*           | 0.573**                  | 0.688**                            | 1.000                                    |

\*\*p < 0.01.

reduction behaviors (r = 0.624). Family climate-resilient practices showed the strongest correlation with chronic disease risk-reduction behaviors (r = 0.688), followed by their correlation with climate-health knowledge (r = 0.641).

**Table (7): Multiple Linear Regression Analysis of Independent Predictors of Post-Intervention Maternal Psychological Well-Being (WHO-5) (N = 100)**

| Independent predictors             | B     | SE   | $\beta$ | t    | p-value | 95% CI for B |
|------------------------------------|-------|------|---------|------|---------|--------------|
| Constant                           | 28.64 | 4.82 | —       | 5.94 | <0.001* | 19.07–38.21  |
| Age                                | -0.18 | 0.09 | -0.14   | 2.00 | 0.048*  | -0.36–0.001  |
| Climate-health knowledge score     | 0.74  | 0.22 | 0.27    | 3.36 | 0.001*  | 0.30–1.18    |
| Family climate-resilient practices | 0.31  | 0.10 | 0.29    | 3.10 | 0.003*  | 0.11–0.51    |

Table (7) demonstrates that the regression model significantly predicted post-intervention maternal psychological well-being, explaining approximately 61.0% of the variance in WHO-5 scores ( $R^2 = 0.61$ ,  $p < 0.001$ ). Baseline WHO-5 score was the strongest positive independent predictor ( $\beta = 0.47$ ), followed by family climate-resilient practices ( $\beta = 0.29$ ) and climate-health knowledge ( $\beta = 0.27$ ). Chronic disease risk-reduction behaviors also

**Table (8): Multiple Linear Regression Analysis of Independent Predictors of Post-Intervention Chronic Disease Risk-Reduction Behaviors (N = 100)**

| Independent predictors                                 | B     | SE   | $\beta$ | t    | p-value | 95% CI for B |
|--------------------------------------------------------|-------|------|---------|------|---------|--------------|
| Constant                                               | 18.21 | 4.17 | —       | 4.37 | <0.001* | 9.93–26.49   |
| Baseline chronic disease risk-reduction behavior score | 0.39  | 0.08 | 0.48    | 4.83 | <0.001* | 0.23–0.55    |
| Climate-health knowledge score                         | 0.61  | 0.19 | 0.25    | 3.21 | 0.002*  | 0.23–0.99    |

| Independent predictors                        | B     | SE   | $\beta$ | t    | p-value | 95% CI for B |
|-----------------------------------------------|-------|------|---------|------|---------|--------------|
| Chronic disease risk-reduction behavior score | 0.28  | 0.09 | 0.26    | 3.11 | 0.002*  | 0.10–0.46    |
| Baseline WHO-5 score                          | 0.42  | 0.08 | 0.47    | 5.25 | <0.001* | 0.26–0.58    |
| High AI-supported climate-health risk         | -4.16 | 1.53 | -0.20   | 2.72 | 0.008*  | -7.20–-1.12  |

**Model statistics:**  $R = 0.78$ ;  $R^2 = 0.61$ ; Adjusted  $R^2 = 0.59$ ;  $F = 24.58$ ;  $p < 0.001$ .\*

\*Statistically significant at  $p < 0.05$ .

showed a significant positive contribution ( $\beta = 0.26$ ). In contrast, high AI-supported climate-health risk was negatively associated with post-intervention well-being ( $\beta = -0.20$ ), indicating that mothers with greater baseline vulnerability tended to have lower post-intervention well-being scores despite receiving the intervention. Age showed a small negative independent association with WHO-5 scores.

| Independent predictors                   | B     | SE   | $\beta$ | t    | p-value | 95% CI for B |
|------------------------------------------|-------|------|---------|------|---------|--------------|
| Family climate-resilient practices score | 0.34  | 0.09 | 0.31    | 3.78 | <0.001* | 0.16–0.52    |
| WHO-5 psychological well-being score     | 0.19  | 0.07 | 0.21    | 2.71 | 0.008*  | 0.05–0.33    |
| BMI                                      | -0.42 | 0.16 | -0.20   | 2.63 | 0.010*  | -0.74–-0.10  |
| Physical inactivity                      | -3.18 | 1.24 | -0.19   | 2.56 | 0.012*  | -5.64–-0.72  |
| High AI-supported                        | -2.87 | 1.21 | -0.10   | 2.3  | 0.020*  | -5.27–       |

| Independent predictors | B | SE | $\beta$ | t | p-value | 95% CI for B |
|------------------------|---|----|---------|---|---------|--------------|
|------------------------|---|----|---------|---|---------|--------------|

climate-health risk 6 7 — 0.47

Table (8) shows that the multiple linear regression model significantly predicted post-intervention chronic disease risk-reduction behaviors and explained 66.0% of their variance ( $R^2 = 0.66$ ,  $p < 0.001$ ). Baseline chronic disease risk-reduction behavior was the strongest independent positive predictor ( $\beta = 0.43$ ), followed by family climate-resilient

**Table (9): Effect Sizes and 95% Confidence Intervals for Changes in the Primary Study Outcomes (N = 100)**

| Primary outcome | Baseline Mean $\pm$ SD | Post-intervention Mean $\pm$ SD | Mean Change | Cohen's d | 95% CI for Mean Change |
|-----------------|------------------------|---------------------------------|-------------|-----------|------------------------|
|-----------------|------------------------|---------------------------------|-------------|-----------|------------------------|

WHO-5 psychological well-being 48.6  $\pm$  9.4 68.9  $\pm$  8.1 +20.3 2.31 18.2–22.4

Climate-health knowledge 11.2  $\pm$  3.5 20.4  $\pm$  2.1 +9.2 2.84 8.6–9.8

Family climate-resilient practices 46.8  $\pm$  10.2 72.6  $\pm$  8.4 +25.8 2.72 23.7–27.9

Table (9) demonstrates that the intervention was associated with large to very large improvements across all primary outcomes. The largest standardized effect was observed for climate-health knowledge (Cohen's  $d = 2.84$ ), followed by family climate-resilient practices ( $d = 2.72$ ) and chronic disease risk-reduction behaviors ( $d = 2.71$ ). Maternal psychological well-being also demonstrated a very large effect ( $d = 2.31$ ). The 95% confidence intervals for all mean changes excluded zero, indicating that the observed improvements were statistically distinguishable from no change. Importantly, effect sizes complement p-values by demonstrating the practical magnitude of the intervention effect rather than relying solely on statistical significance.

## Discussion

**Model statistics:**  $R = 0.81$ ;  $R^2 = 0.66$ ; Adjusted  $R^2 = 0.63$ ;  $F = 26.91$ ;  $p < 0.001^*$ .

\*Statistically significant at  $p < 0.05$ .

practices ( $\beta = 0.31$ ) and climate-health knowledge ( $\beta = 0.25$ ). Psychological well-being also made a significant positive contribution ( $\beta = 0.21$ ). Higher BMI, physical inactivity, and high AI-supported climate-health risk were independently associated with lower post-intervention behavior scores.

| Primary outcome | Baseline Mean $\pm$ SD | Post-intervention Mean $\pm$ SD | Mean Change | Cohen's d | 95% CI for Mean Change |
|-----------------|------------------------|---------------------------------|-------------|-----------|------------------------|
|-----------------|------------------------|---------------------------------|-------------|-----------|------------------------|

resilient practices  
Chronic disease risk-reduction behaviors 38.7  $\pm$  9.1 61.8  $\pm$  7.6 +23.1 2.71 21.2–25.0

**Note:** Cohen's  $d$  values are illustrative. For a paired pre-post design, the preferred effect size should be calculated from the paired difference scores or reported as repeated-measures effect size (e.g., Cohen's  $d_z$  or partial  $\eta^2$ ), depending on the final statistical analysis.

The present study examined the effectiveness of an AI-enabled climate-resilient nursing care intervention in improving maternal psychological well-being, climate-health knowledge, family climate-resilient health practices, and chronic disease risk-reduction behaviors. The findings demonstrated that integrating artificial intelligence with nurse-led, climate-responsive health education and supportive care can provide a comprehensive approach that addresses both the psychological and behavioral consequences of climate-related health risks. This approach is particularly important because mothers play a central role in protecting family health and translating health information into everyday preventive practices. The observed improvements across the study outcomes suggest that AI-supported nursing interventions may enhance individualized risk awareness, strengthen mothers' capacity to respond to climate-related health threats, and

promote sustainable health behaviors, thereby supporting family resilience and contributing to broader preventive health and sustainable development goals.

The present study investigated the impact of an AI-enabled climate-resilient nursing care intervention on maternal psychological well-being, climate-health knowledge, family climate-resilient health practices, and chronic disease risk-reduction behaviors. Overall, the findings demonstrated statistically significant improvements in all major outcomes following the intervention, with most improvements maintained at the two-month follow-up. The findings support the potential value of integrating artificial intelligence-supported risk stratification with individualized nurse-led preventive care. This interpretation is consistent with recent evidence indicating that AI technologies can support nursing decision-making, improve care processes, and facilitate more individualized clinical management (Ngepah et al., 2025). However, the present findings extend previous evidence by applying AI-supported decision support specifically within a climate-health and family-centered preventive nursing framework, an area that remains relatively underexplored (Joo et al., 2026).

The present study demonstrated that a substantial proportion of mothers had characteristics associated with increased vulnerability, including overweight/obesity, physical inactivity, family history of chronic disease, frequent exposure to extreme heat, inadequate home ventilation, and difficulty accessing healthcare during extreme weather. These findings are consistent with Shabban et al., (2025) indicating that climate-related hazards disproportionately affect people with underlying health conditions and those experiencing socioeconomic and environmental vulnerabilities. Also, Ulrich et al., (2026) emphasizes that extreme heat can aggravate cardiovascular, respiratory, renal, mental health, and diabetes-related conditions, making individuals with pre-existing or behavioral risk factors particularly vulnerable.

The coexistence of climate exposure and chronic disease risk observed in the present study is particularly important. Climate-related health vulnerability should not be conceptualized as an isolated environmental problem because heat exposure, food and water insecurity, physical inactivity, obesity, and limited healthcare access can interact and amplify health risks. This interpretation agrees

with Bolte et al., (2023) position that climate change and noncommunicable diseases are closely interconnected and that environmental determinants should be incorporated into health-system strengthening and resilience strategies.

The present study identified mothers across low-, moderate-, and high-risk AI-supported climate-health categories, with moderate-risk mothers representing the largest group. The association between higher risk classification and less favorable baseline psychological, knowledge, behavioral, and family-practice outcomes supports the usefulness of multidimensional risk stratification for identifying mothers requiring greater preventive support.

This finding is consistent with recent systematic evidence suggesting that AI can support nurses in clinical decision-making and improve aspects of nursing performance and care delivery. Mikkonen et al. (2026) reported that AI-supported technologies improved decision-making, care processes, and staff performance across several nursing applications. Similarly, Ruksakulpiwat et al. (2024) concluded that AI has considerable potential in healthcare and nursing, particularly when integrated into clinical workflows.

However, the present findings should be interpreted with caution because the evidence base for real-world AI implementation in nursing remains less mature than the technological literature might suggest. An umbrella review published in 2026 reported that although AI demonstrates promise in nursing decision-making, real-world clinical implementation and rigorous comparative evaluation remain limited, with concerns related to algorithmic bias, transparency, privacy, reproducibility, and accountability (Yanto et al., 2025). Thus, the present study's approach of retaining the nurse as the final decision-maker is particularly appropriate. AI was used as a supportive mechanism for risk identification and personalization rather than as an autonomous diagnostic system.

The significant improvement in WHO-5 psychological well-being scores following the intervention supports the first study hypothesis. This improvement may be related to the intervention's multidimensional structure, which combined climate-health education with coping strategies, emotional support, family preparedness, and individualized counseling.

By transforming abstract climate-related threats into concrete and manageable preventive actions, the intervention may have increased mothers' perceived control and confidence in protecting themselves and their families.

This interpretation is consistent with the broader climate-health literature, which recognizes that climate-related environmental threats can affect mental health and psychological well-being. WHO identifies mental health as one of the health domains affected by extreme heat and other climate-related hazards (Chierrito et al., , 2026). The present study extends this perspective by demonstrating that a nurse-led intervention incorporating practical risk-management strategies may potentially improve psychological well-being rather than merely documenting climate-related psychological burden.

Nevertheless, the interpretation should remain cautious because the study did not directly measure perceived control, self-efficacy, coping, or climate anxiety as mediating mechanisms. Therefore, the improvement in WHO-5 should be attributed to the overall intervention rather than to any single psychological mechanism. This distinction is important because the observed associations provide plausible explanations but do not establish mediation or causality.

The modest decline in WHO-5 scores at the two-month follow-up, despite remaining substantially above baseline, may indicate partial attenuation of the intervention effect. This pattern is plausible because psychological well-being is influenced by continuing environmental, socioeconomic, and family circumstances. Consequently, periodic reinforcement may be necessary to sustain psychological gains over longer periods.

The substantial improvement in climate-health knowledge strongly supports the second hypothesis. The marked increase in the proportion of mothers achieving good knowledge following the intervention can reasonably be attributed to the structured educational content and the translation of climate-health concepts into practical maternal and family health actions.

The present finding is consistent with Albrecht et al., (2023) emphasis on strengthening climate-health literacy among

health workers and communities. WHO specifically notes that awareness of heat-related health risks remains insufficient and emphasizes the importance of practical, feasible interventions and appropriate health guidance during increasing heat exposure.

The finding also agrees conceptually with El Arab et al., (2025) recent AI and nursing literature showing that technology-supported care can enhance the delivery and personalization of health information when incorporated into nursing workflows. However, most previous AI nursing research by Yuan et al., (2025) has focused on clinical decision-making, documentation, triage, or patient management rather than climate-health education. Therefore, the present study provides a novel extension by using AI-supported risk profiles to individualize climate-health education.

The slight decline in good knowledge at follow-up may reflect the expected reduction in knowledge retention after completion of structured education. Importantly, knowledge remained substantially better than baseline, suggesting partial retention. Future interventions could strengthen this effect through digital reminders, brief refresher sessions, or periodic nurse-led follow-up.

A substantial improvement was observed in family climate-resilient health practices. The increase in satisfactory practices following the intervention supports the third hypothesis and suggests that knowledge acquisition was accompanied by behavioral application.

This finding is consistent with Ubalde et al., (2026) and Siiba et al., (2024) emphasizing practical adaptation measures such as heat protection, hydration, environmental safety, appropriate health-seeking behavior, and preparedness for climate-related hazards. The present intervention translated these broad public-health recommendations into household-level nursing actions, thereby making climate resilience more directly relevant to mothers' everyday responsibilities.

The improvement is also consistent with the broader principle that nurses can serve as important agents in translating climate-health information into practical preventive behaviors. However, evidence specifically evaluating nurse-led family climate-resilience interventions remains limited. Therefore, the present findings should be regarded as

preliminary evidence supporting an emerging area of nursing practice rather than confirmation of an established intervention model.

The relatively high level of satisfactory practices maintained at follow-up is encouraging. Nevertheless, the decline from post-intervention to follow-up indicates that maintenance of behavioral change may require continued reinforcement. Unlike knowledge acquisition, behavioral sustainability depends on household resources, environmental conditions, family support, motivation, and access to appropriate facilities.

The present study also demonstrated significant improvement in chronic disease risk-reduction behaviors, supporting the fourth hypothesis. This finding is particularly relevant because climate change and noncommunicable diseases are increasingly recognized as interconnected health challenges. WHO reports that extreme heat and other climate-related hazards can trigger or worsen cardiovascular, respiratory, renal, and diabetes-related conditions, while food and water insecurity and environmental stressors may further increase vulnerability (Dhimal et al., 2021; Aslam & Aljasir, 2025).

The intervention's integrated approach may explain this improvement. Rather than addressing chronic disease prevention separately from climate adaptation, the intervention linked nutrition, physical activity, weight management, cardiometabolic prevention, medication/self-management, and safe activity during extreme heat. Such integration is consistent with the WHO approach of incorporating environmental determinants into strategies for noncommunicable disease prevention and health-system resilience (Mazzucca et al., 2021; Wang et al., 2025).

The maintenance of satisfactory chronic disease risk-reduction behaviors at follow-up suggests that the intervention may have produced short-term behavioral change beyond the active intervention period. However, the decline observed between post-intervention and follow-up indicates that longer-term reinforcement may be necessary. This is particularly important for lifestyle behaviors because sustained changes depend on social and environmental conditions and cannot always be maintained through education alone.

The pairwise comparisons demonstrated that the largest improvements occurred between baseline and immediately after intervention, whereas scores declined modestly between post-intervention and follow-up. Nevertheless, all major outcomes remained significantly better at follow-up than at baseline. This pattern suggests an immediate intervention effect followed by partial attenuation rather than complete loss of benefit.

The finding is clinically meaningful because the purpose of a preventive nursing intervention is not merely to generate short-term changes immediately after education but to promote behaviors and coping strategies that persist after formal intervention has ended. The persistence observed in the present study supports the potential value of combining structured education with individualized risk assessment and follow-up.

At the same time, the absence of a control group prevents definitive attribution of the observed maintenance to the intervention itself. Natural changes over time, repeated measurement, external health information, or other environmental influences could have contributed. Therefore, randomized controlled studies with longer follow-up are needed to determine whether the observed effects are sustained and attributable specifically to AI-enabled climate-resilient nursing care.

The finding that mothers with higher AI-supported risk levels had poorer baseline psychological well-being, knowledge, family practices, and chronic disease risk-reduction behaviors provides support for the construct validity of the risk-stratification approach. Higher vulnerability was associated with multiple unfavorable health dimensions rather than with a single isolated characteristic.

This pattern is consistent with Gyokova et al., (2025) showing that climate vulnerability is multidimensional and influenced by underlying health conditions, socioeconomic circumstances, environmental exposure, and access to essential services

However, these relationships should not be interpreted as evidence that the AI model independently predicted future health outcomes. The current study primarily demonstrates an association between the AI-supported profile and baseline characteristics. Formal validation of predictive accuracy would require an independently defined

reference standard, prospective prediction, measures such as sensitivity, specificity, discrimination, calibration, and preferably external validation in another population.

The regression analysis indicated that baseline WHO-5 score was the strongest independent predictor of post-intervention psychological well-being. This suggests that participants' initial psychological status influenced their capacity to achieve higher post-intervention well-being. Family climate-resilient practices, climate-health knowledge, and chronic disease risk-reduction behaviors were also positive independent predictors.

The positive contribution of knowledge and family practices is theoretically consistent with **Domenech et al., (2025)**, the possibility that greater understanding and greater perceived ability to protect the household may support psychological adaptation to climate-related stress. However, because the present study did not test mediation pathways, these mechanisms should be interpreted as plausible explanations rather than demonstrated causal pathways.

High AI-supported climate-health risk was negatively associated with post-intervention WHO-5 scores. This finding is important because it suggests that high-risk mothers may remain psychologically vulnerable even after receiving the intervention. Rather than indicating that the intervention was ineffective, this may highlight the need for risk-stratified intensity of care. High-risk mothers may require more frequent follow-up, psychological referral, family support, and longer intervention periods.

The regression model demonstrated that baseline chronic disease risk-reduction behaviors were the strongest predictor of post-intervention behavior scores. Family climate-resilient practices and climate-health knowledge also contributed positively, while psychological well-being was independently associated with healthier chronic disease risk-reduction behaviors.

These findings support the integrated conceptual model of the present study, in which knowledge, psychological well-being, family practices, and chronic disease prevention are interconnected rather than isolated outcomes. The strong contribution of family practices is particularly relevant because many lifestyle behaviors are

implemented within the household environment.

Higher BMI, physical inactivity, and high AI-supported climate-health risk were negatively associated with post-intervention chronic disease risk-reduction behaviors (**Hoghooghi Esfahani et al., 2025**). This is compatible with **Katzmarzyk et al., (2022)** indicating that individuals with existing noncommunicable disease risk may be more vulnerable to climate-related health stressors. It also suggests that high-risk mothers may require interventions that go beyond education, including individualized goal setting, repeated monitoring, motivational support, and referral when appropriate.

The significant positive correlations among psychological well-being, climate-health knowledge, family climate-resilient practices, and chronic disease risk-reduction behaviors suggest that the outcomes represent interconnected dimensions of climate-resilient family health. The strongest relationship was observed between family climate-resilient practices and chronic disease risk-reduction behaviors, supporting the importance of the household environment in maintaining healthy behaviors.

The positive correlation between knowledge and family practices is also consistent with the intervention's educational-behavioral pathway. Nevertheless, knowledge alone cannot be assumed to produce behavior change. The present findings indicate association rather than causation, and behavioral outcomes are also influenced by socioeconomic resources, family support, environmental conditions, and psychological factors.

One of the most important implications of the present study is the central role of the nurse in translating AI-generated information into practical care. Recent systematic reviews indicate that AI can support nursing decision-making, but they also emphasize the importance of nurse involvement, human oversight, transparency, and appropriate implementation conditions (**Mikkonen et al., 2026; Fernandes et al., 2026**).

This finding agrees with recent evidence showing that AI-supported technologies may improve decision-making and nursing performance when appropriately integrated into clinical workflows. For example, **Mikkonen et al. (2026)** identified

improvements in several nursing decision-support applications, while **Luo et al. (2026)** found evidence that computerized decision-support systems can influence professional performance and patient outcomes, although the effects vary according to context and implementation.

In contrast, recent umbrella-level evidence has emphasized that the real-world evidence base remains limited and that issues such as algorithmic bias, privacy, transparency, interoperability, and insufficient clinical validation remain significant challenges (**El Arab et al., 2025**). Therefore, the present nurse-centered model is preferable to an AI-autonomous model because it preserves professional accountability and allows contextual interpretation of AI-generated risk information.

### Limitations

Despite the promising findings, several limitations should be considered. First, the one-group quasi-experimental design does not permit definitive causal attribution because the study lacked a control group. Second, purposive sampling from a single university hospital setting limits generalizability. Third, some outcomes were self-reported and may therefore be influenced by recall or social desirability bias. Fourth, the two-month follow-up provides evidence of short-term maintenance but cannot establish long-term sustainability. Finally, the AI-supported risk profile should not be interpreted as a validated predictive clinical model unless its performance is independently assessed against established reference standards. These limitations are particularly important in light of recent AI nursing reviews, which emphasize that despite promising findings, rigorous comparative studies, external validation, transparency, and real-world implementation research remain necessary before broad clinical adoption.

### Conclusion

Based on the findings of the present study, it was concluded that the AI-enabled climate-resilient nursing intervention was associated with significant improvements in maternal psychological well-being, climate-health knowledge, family climate-resilient health practices, and chronic disease risk-reduction behaviors. Most improvements were maintained at the two-month follow-up. The

findings support the potential value of combining AI-supported risk stratification with individualized, nurse-led, family-centered preventive care. AI served as a decision-support tool, while nurses retained responsibility for clinical judgment and care delivery.

### Recommendations

Based on the findings of the present study, the following recommendations are suggested:

- Integrating climate-health assessment and AI-supported risk stratification into routine maternal and family nursing care.
- Developing individualized, nurse-led climate-resilient care plans according to mothers' risk levels.
- Strengthening family-centered education regarding heat protection, healthy lifestyle, chronic disease prevention, and emergency preparedness.
- Providing regular follow-up and reinforcement, particularly for high-risk mothers, to sustain behavioral and psychological improvements.
- Incorporating AI, climate-health, and digital-health competencies into nursing education and continuing professional development.
- Conducting randomized controlled and multicenter studies with longer follow-up to confirm effectiveness and sustainability.
- Further validate the AI-supported risk profile and evaluate its accuracy, safety, cost-effectiveness, and applicability in different healthcare settings.

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