

# Role of Female Labor Force Participation on Climate Change Risk and Human Security in Selected Districts of Punjab

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## Abstract

*Our study aims to assess the impact of climate change risk on human security of households in selected districts of Punjab, Pakistan namely, Rawalpindi, Lahore, Bahawalpur and Sialkot. We further, aim to ascertain if female labor force participation in the household leads to increase in household's ability to withstand climate change risk to its human security. By incorporating people's perception of climate change, the study is based on the data collected from 1000 households of the four districts of Punjab with an equal representation of rural and urban areas. Regression analysis shows climate change as a major security risk and consistently yields deteriorating effect on human security. While incorporating female labor force participation in the model, results show a positive impact of female labor force participation on human security. Further, the interaction term between climate change risk index and female labor force participation depicts varying but insightful outcomes for human security and its constituents i.e. health, food and economic security. Our data depicts that only 328 out of 1007 households had female earners while the average proportion of female earners was about 16% in the households, which may account for the possibility of a few statistically insignificant coefficient. Though consistently positive sign of the coefficient makes a strong case for female labor force participation in enhancing human security of households via tackling climate change risk effectively. These results highlight the need for removal of barriers to female labor force participation at the household level to enable them to play their profound role in combating climate change risk and its repercussions for human security.*

**Keywords:** Climate change, human security, female labor force, participation, Punjab

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## 1. INTRODUCTION

Human security, defined as “a condition that exists when the vital core of human lives is protected and when people have the freedom and capacity to live with dignity (Adger et al., 2014, pp. 759), is a fundamental human right. It encompasses various aspects of human life, such as livelihood, nutrition, and health. A lack of security in these areas leads to stress and suffering. At the household level, human security involves food security, health security, and economic security. These are influenced by demographic and macroeconomic factors, with climate change being significant but uncontrollable factors.

Climate change poses a severe threat to human security, affecting nutrition, water quality, the emergence of diseases and loss of livelihood. Pakistan is notably vulnerable, ranked 8th globally for climate change risk (Germanwatch, 2021). The country has experienced frequent natural disasters, leading to significant economic and human losses. Projections indicate worsening food insecurity and health outcomes, with substantial impacts on the population's well-being and GDP.

Female labor force participation can potentially enhance a household's resilience to climate change. By diversifying income sources (Dey et al., 2018), it reduces economic vulnerability, ensuring a steadier flow of resources even when climate and related shocks occur. Women's employment can also lead to improved household decision-making, promoting adaptive strategies such as better resource management

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and investment in sustainable practices (Kim, 2022; Wang and Zhang, 2020). Furthermore, increased financial independence for women can bolster education and health outcomes for the entire family, enhancing overall well-being. Thus, female labor force participation not only strengthens household economic stability but also fosters a more adaptive and resilient response to climate change challenges.

This study focuses on assessing the role of female labor force participation in moderating the impact of climate change on human security of households in Punjab, Pakistan. By collecting data from diverse districts, namely, Rawalpindi, Sialkot, Bahawalpur and Lahore, we aim to understand perceptions of climate risk and its effects on human security. Our approach highlights the importance of integrating gender-focused economic policies to enhance household adaptability and resilience against climate change risks.

## **2. LITERATURE REVIEW**

Climate change and related calamities affect various dimensions of human security in multiple ways. The impact of climate change on food security is transmitted primarily through three sources: soil, water and crops. Further, when crops fail due to climate-related disasters it renders farmers unable to support their families (McGuire, 2015). The reduction in food production owing to climate-related disasters may also translate into food insecurity by pushing-up the price of food (Islam & Wong, 2017). Climate change also reduces the nutritional value and variety of food available by disrupting trade, affecting soil quality and destroying crops (St. Clair & Lynch, 2010). The empirical work also proves that climatic shocks adversely affect the quantity as well as the quality of

food and hence may lead to food insecurity (Dhimal et al., 2021; Oduniyi, 2018; Oduniyi, 2018; Poudel et al., 2017; Vaghefi et al., 2016; Geffersa, 2014; Lake et al., 2012)

Compounding the impact of climate change risk on food are its implications for human health. Climate related natural disasters may result in contamination of water sources used for hydration as well as agricultural practices (IPCC, 2013). Heat and extreme events cause mortality due to exposure. Poor air quality results in chronic respiratory issues while diminished food production causes malnutrition. Extreme heat elevates risks of heat exhaustion, heat stroke, and death, particularly for people who have to work outside (IPCC, 2014). In urban areas climate change has instigated a state of perpetual threat of injury and loss which may create chronic stress (Portier et al., 2010). Chadwick (2016) and IPCC (2014) identify that health effects of climate change are a composite of sensitivity and exposure to climate-related dangers. Further, sensitivity to climate change risks is unevenly distributed (IPCC, 2014). These arguments have been supported by the empirical literature carried out in various economies around the globe (Babar et al., 2021; Abedin et al., 2019; Ajaz & Majeed, 2018; Leyva et al., 2017; Paavola, 2017; Kabir et al., 2016; Haque et al., 2012).

Climate change risk can be considered as shock that can affect both demand and supply side of the economy including infrastructure, transportation, telecommunication, tourism, financial services (Defra et al., 2012; Arent et al., 2014). Global warming and higher temperatures can also lead to economic losses by reducing labor productivity and agriculture output (Dell et al., 2014). Similarly, on the demand side, the extreme weather events (e.g. storms and floods) can adversely affect households' wealth and hence consumption. There is a vast body of literature that empirically proves the harmful economic effects of climate change e.g. Dellink, Lanzi & Chateau (2019); Bosello et al. (2012); Dell et al. (2012); Gasper et al. (2011); Gassebner et al. (2010); Oh & Reuveny (2010); Kumar & Parikh, (2001) among others.

The ability of societies to cope with climate change depends upon several factors. Among these, women's active economic role is an important factor in formulating a response to climate change. Financially

independent women have been proven to be more likely to invest in sustainable and climate resilient practices and infrastructure (UNDP, 2019; UNEP, 2019). Additionally, economically active women have a say in decision making and are likely to advocate climate friendly policies (WEDO, 2018). Women have also been empirically proven to be an important agent in climate change adaptation process (Matinda, 2010; Mitchell et al., 2007; Al-Naber & Shatanawi, 2004). Studies have also shown that women’s active role in labor force contributes towards reducing harmful effects of climate change on household’s well-being. Increased income as a result of increased female participation in labor force helps in household’s energy transition (Burke & Dundas, 2015).

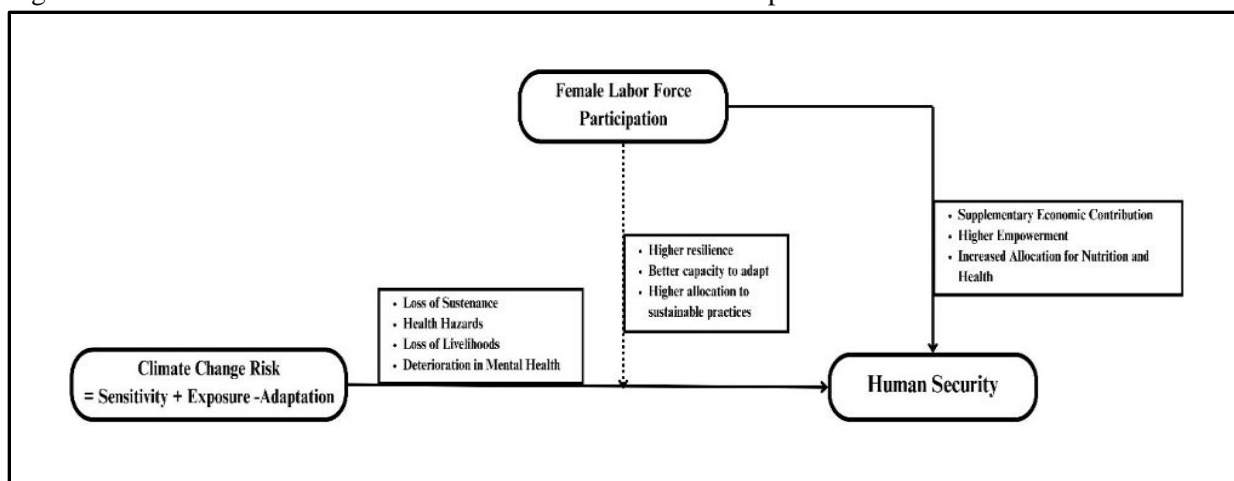
### 3. METHODOLOGY

#### 3.1. Theoretical Framework

The role of women in improving the human security of a household is multifaceted. Women who participate in the labor force supplement household income, gain enhanced skills, and exercise greater control of economic allocations improving overall welfare by enabling consumption of a diverse and nutritious diets, facilitating access to healthcare, sanitation, health insurance, and reducing risks associated with single source earnings etc. Further, women’s labor force participation may increase their bargaining power, resulting in prioritization of spending on nutrition, education, and health.

Climate change risk, characterized by extreme weather events and environmental degradation, presents significant challenges to household’s human security. Female labor force participation (FLFP) can act as a moderating factor in this relationship by changing how households respond to climate-related shocks. Climate risks disrupt agricultural productivity and access to nutritious food. Additionally, climate-related extreme weather events and environmental changes exacerbate health risks through malnutrition, diseases, and reduced access to healthcare. Livelihoods for many a households tend to be climate-sensitive resulting in increased volatility in earnings.

Figure 1: Conceptual Framework



Women’s participation in the labor force introduces additional income sources, reducing dependency on climate-sensitive earnings and enhancing financial capacity to invest in adaptive measures. Female labor force participation also results in greater resilience by enabling savings and insurance products that help households manage climate-induced shocks. Women’s incomes are more likely to be allocated toward health, nutrition, and education, which improve long-term adaptive capacities.

### 3.2. *Econometric Model*

Based on our theoretical framework the following econometric model is constructed to assess the impact of climate change risk on human security:

$$HSI_i = \alpha_0 + \alpha_1 CCRIndex_i + \alpha_2 FE_i + \alpha_3 (CCRIndex_i * FE_i) + \sum_{j=4}^n \alpha_j X_{ij} + \mu_i \quad (1)$$

Where  $HSI_i$  stands for the value of Human Security Index for household  $i$ ,  $CCRIndex_i$  is the climate change risk faced by household  $i$ ,  $FE_i$  is the dummy for whether there are female earners in the household and  $X_{ij}$  represents control variables related to household  $i$  which are gender of the head of household, region, secondary occupation of household head, family type and indebtedness.

Our dependent variable is human security of household. Household human security will be measured through an index that considers several aspects, including food security, health, and livelihood (Kumssa & Kiriti-Nganga, 2016). Our indicator of human security comprises three dimensions: food security, health security, and economic security. Food security is defined as access to safe, nutritious, and sufficient food. Health security refers to a household's overall health status and vulnerability to illnesses. Finally, economic security is defined as a means of earning a livelihood and their reliability and sustainability. Together, these three elements combine to formulate a household's human security.

We hypothesize that female labor force participation and climate change risk are two key determinants of household human security. Female labor force participation is operationalized as the dummy for whether the household includes a female earner. The female earner in the household is likely to contribute to improved food security, health, and economic security (Pérez et al., 2015). Kiefer et al. (2005) find that women have more awareness about nutrition and hygiene as compared to men. Sangwan & Kumar (2021) elicit that female labor force participation is linked with dietary-diversity and household's production. According to Burke & Dundas (2015) female labor force participation is associated with positive health outcomes for the households.

Climate change risk faced by households has three essential components namely, sensitivity, exposure, and adaptation. Once we understand climate change risk and its constituents, we must recognize that the greatest threat climate change risk poses are to the human security of a household. Climate change risk can affect the human security of the household through any of its components as climate change can adversely affect access to food, deteriorate health and devastate livelihood. Hence, we can assert that the climate change risk faced by a household will lead to the deterioration of its human security. Climate change places a heavy toll on the quality of life and general wellbeing (Chaudhry, 2017). It adversely affects production and availability of food, creates physical and psychological health hazards, devastates livelihood, destroys assets and reduces the ability to work.

The role of female labor force participation in moderating the effect of climate change risk on human security of households is explored through the interaction between climate change risk and female labor force participation dummy. Female earners also play a key role in managing household resources to build resilience to climate change (Pérez et al., 2015). Mavisakalyan and Tarvedi (2019) hold the view that women whenever, given the opportunity demonstrate more environmentally conscious preferences. This view was reinforced by Kim (2022). That translates into reduction in emissions due to female labor force participation (Wang and Zhang, 2020). Dey et al. (2018) are of the view that women play a notable role in nutrition and resource management of households which contribute to household resilience to climate change risk. Achuo et al. (2023) link female labor force participation to environmental sustainability, neutralizing of the impact of climate change. Md, et al. (2022) establish that female labor force participation

enables higher levels of adaptation as well as partially insulates the household from exposure to economic shocks, reducing the risk posed by climate change to household's human security.

The gender of the head of the household has been taken as a control variable. Households headed by men are expected to have a higher level of human security as compared to female-headed households (Amaza, 2006) and in case of a country like Pakistan women generally become heads of their households as outcomes of serious shocks like loss of male earner due to death, disability, or abandonment. Indebtedness is also taken as a dummy variable taking a value 1 if the household is currently indebted. We expect that indebted households have a low level of human security as compared to non-indebted households. This is so because indebted households have economic liabilities that add to the economic stress and lowers household's ability to withstand any economic or health related shock resulting in lower human security outcomes.<sup>2</sup> Further, the dummy for household head having a secondary occupation is also incorporated to assess whether more than one sources of income improves human security of households. It is expected to have a positive sign as it not only supplements the primary source of income improving the economic situation of the household but also insulates the household from unforeseen shocks caused by climate change. We have also added the dummy for nuclear family with expectation that a joint family system provides the necessary family support for withstanding uncertain situations.

### ***3.2.a. Sample and Data Collection***

The data was collected from four Districts of Punjab namely Rawalpindi, Sialkot, Lahore, and Bahawalpur. In order to ensure uniform representation from North and South Punjab, we have opted for an equal sample size from each district and within districts from each tehsil.<sup>3</sup> A total of 1000 households were selected for data collection through a questionnaire, filled through interviews with the household heads using a nonprobability purposive sampling technique. The questionnaire comprises three sections: demographic profile, human security of the household, and climate change risk faced by the household.<sup>4</sup>

### ***3.2.b. Construction of Indices***

Our analysis involves construction of two household level indices for human security and climate change risk. The responses collected through questionnaire were used to construct both the indices. The detailed descriptions of the process of index development are discussed in the subsequent two sub-sections.

#### **3.2.bi. Climate Change Risk (CCR) Index**

The sensitivity of a household to climate change refers to the extent to which it is impacted by climate change effects. The household's exposure to climate change risk encompasses the experiential dimension of climate change, namely the degree to which the household has encountered climate change risks irrespective of the actual impact on the household. Both sensitivity and exposure combine to reflect the overall level of climate change risk. However, the role of adaptation in mitigating the climate change risks experienced by households cannot be overlooked. Adaptation is the ability of the household to respond and adjust to climate change using various strategies, which would reduce climate change risk. Thus, the net climate change risk faced by a household is the aggregate of its sensitivity and exposure, discounted by the household's level of adaptation. The study uses the Intergovernmental Panel on Climate Change (IPCC)

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<sup>2</sup> The table of Summary Statistics is provided in Appendix A1.

<sup>3</sup> From Bahawalpur all five tehsils namely, Hasilpur, Khairpur Tamewali, Ahmadpur East, Yazman and Bahawalpur were selected. We also accessed data from all four tehsils of Sialkot district namely, Daska, Pasrur, Samrial and Sialkot. In Rawalpindi district data was collected from tehsils, Gujar Khan, Kahuta, Kallar Syedan, Murree, Taxila, Kotli Sattian and Rawalpindi City. Lastly, all four tehsils of Lahore district namely, Model Town, Raiwind, Shalimar and Lahore were also accessed for data collection.

<sup>4</sup> Questionnaire can be provided on demand.

definition of vulnerability for Climate Change Risk (CCR) as given below:<sup>5</sup>

$$CCR = Exposure + Sensitivity - Adaptability \quad (2)$$

The climate change risk is the degree to which a system is vulnerable to the adverse effects of climate change, including variability and extreme climate conditions. The risk in itself is the function of the character, magnitude, and rate of climate variations to which the system is exposed, sensitive and reflects adaptive capacity. Four major climatic events, namely temperature, rainfall, floods and windstorm, are considered. The calculated values of the Climate Change Risk Index (CCRIndex) lie between 0 and 1. Here 0 means no risk while 1 means highest risk.

### 3.2.bii. Human Security Index

To construct the human security index, we have taken three core dimensions of human security: food, health and economic security. For each of these dimensions we have calculated individual indices and then we have constructed an overall human security index based on the three-dimensional indices.

For food security index, we have adapted Food and Agriculture Organization's (FAO) Food Insecurity Experience Scale (FIES) developed in 2014. This scale, consisting of 8 questions, has been widely used to measure food security at the household or individual level based on experience in terms of food security. After obtaining the yes/no responses on all eight questions, the total score has been obtained. The obtained score is then divided by 8 (maximum score). This way the range of index of food security becomes 0-1, with 1 means complete secure and 0 means completely insecure.

$$Food\ Security\ (FS) = \frac{Total\ obtained\ score}{maximum\ possible\ score} \quad (3)$$

Similarly, for health security there are fourteen items and for economic security there are eleven items. The indices for both health security and economic security are constructed by the authors based on extensive literature review. The items comprise of yes/no questions. For both these indices as well first the total score has been obtained and then that obtained score is divided by the maximum possible score similar to equation 4, again 1 meaning completely secure and 0 meaning completely insecure.

After obtaining the indices on each of the dimensions of human security separately a composite index of human security has been constructed by using the weighted average of these indices as follows

$$HSI_i = 1/3(FS_i + HS_i + ES_i) \quad (4)$$

The value of Human Security Index also ranges between 0 and 1, meaning completely insecure and completely secure, respectively.

### 3.2.c. Estimation Techniques

The econometric model is estimated using simple Ordinary Least Squares (OLS). Since we are using cross sectional data for the analysis the most likely problem that can occur is Heteroscedasticity. Heteroscedasticity tends to increase the variance of the coefficients resulting in lower p-values. The issue can be detected using Breusch-Pagan (BP) and White tests of heteroscedasticity. The null hypotheses for both the tests imply homoscedasticity. We have used both the tests for confirmation and since the tests indicate existence of heteroscedasticity, we have employed robust estimate of variance developed by Hubert (1967) and White (1980, 1982) independently.

## 4. RESULTS AND DISCUSSION

This section presents and discusses empirical findings. The first section deals with descriptive analysis while the second section reports and discusses regression results.

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<sup>5</sup> c.f. Arif et al. (2017).

#### 4.a. Descriptive Analysis

Data presented in Table 1 shows most of the households (73%) have moderate human security, while only 8.2% of households are highly secure in the selected sample. In terms of food security, about 73.3% of the households are highly secure, of the remaining households about 20.1% are highly insecure. The average value of food security index is quite high (0.79). Similarly, about 11.5% of the households have high health insecurity, while 13% are highly secure. The average value of health security index is 0.76. In terms of economic security, about 61% of households are moderately secure, while about 20% of the households are experiencing high economic insecurity. The overall human security index has an average value of 0.723, with only about 8% of the households in the sample being highly secure, compared to 19% coping with high human insecurity.

Table 1 Frequency Distribution of Human Security and its Dimensions

Frequency Distribution of Human Security and its Dimensions				
	Human Security	Food Security	Health Security	Economic Security
Highly Insecure	190 (18.9)	202 (20.1)	116 (11.5)	200 (19.9)
Moderately secure	734 (72.9)	67 (6.7)	761 (75.6)	617 (61.3)
Highly Secure	83 (8.2)	738 (73.3)	130 (12.9)	190 (18.9)
Total	1007 (100)	1007 (100)	1007 (100)	1007 (100)

Looking at the climate change risk and its dimensions, about 89% of the households in our sample are facing moderate to high level of climate change risk. The average value of climate change risk index is 0.56. We have also studied the constituents of climate change risk i.e., exposure, sensitivity and adaptation. On the extremes of the spectrum, about 15% of the households experience high exposure to climate change risk while 12.3% of households experience low exposure. Somewhat different trends can be seen for sensitivity. About 18% of the households experience low sensitivity to climate change risk compared to 12% experiencing high sensitivity. About 70.5% of households have moderate sensitivity to climate change risk. Most households are in our sample (75.4%) have moderate levels of adaptation. Of the remaining 24.5% most have low adaptation (13%). The average adaptation scores are also low at about 0.521.

Cross-tabulation (Table 3- Appendix) between female labor force participation and human security index shows that about 20% of highly insecure households have no female earners compared to 7.36% of highly secure households without female earners. In contrast about 10% of households with female earners are highly secure and 17% are highly insecure. Cross-tabulation between climate change risk and human security index shows that about 22% of highly insecure households are also experiencing high climate change risk, while only 3.6% of the highly secure households have to cope with high climate change risk.

#### 4.b. Regression Results and Interpretation

The regression results of human security, female labor force participation and climate change risk are presented in Table 2. The impact of climate change on human security is consistently significant and negative. This depicts that climate change risk reduces human security. This effect is consistent with our

expectation and its implications tend to be dire. Climate change risk may expose the household to severe uncertainties by reducing production of food, loss of employment opportunities, and increase in morbidity and health-related expenses. This renders household vulnerable to all sorts of insecurities including food, health and economic insecurities. Ajaz & Majeed (2018) and Babar *et al.* (2021) established the impact of climate change risk on human security and wellbeing through the health channel. The economic uncertainty created by climate change risk was explored by Das *et al.* (2020). Further, Ahmad *et al.*, (2016), Ali *et al.*, (2017) and Ullah *et al.*, (2018) also establish the negative relationship between climate change risk and human security. Our results, however, do indicate that climate change risk is statistically insignificant for food security.

Table 2-Regression Estimates for Human Security & Its Constituents

Variables	(1)	(2)	(3)	(4)
	Human Security Index	Economic Security	Food Security	Health Security
Climate Change Risk	-0.1031*** (0.0363)	-0.1063*** (0.0422)	-0.0811 (0.0719)	-0.1132*** (0.0212)
Female Earners (if household has female earners=1)	0.0782*** (0.0311)	0.1372*** (0.0372)	0.1165** (0.0587)	0.0086 (0.0283)
Female Earners * Climate Change Risk	-0.0900* (0.0551)	-0.1304** (0.0640)	-0.1513 (0.1077)	-0.0101 (0.0132)
Gender of Household Head (if female=1)	0.0622*** (0.0197)	0.0761*** (0.0221)	0.1035*** (0.0563)	0.0071 (0.0151)
Indebtedness (if indebted=1)	-0.1563*** (0.0167)	-0.1681*** (0.0163)	-0.2562*** (0.0351)	-0.0440*** (0.0112)
Secondary Occupation of Household Head	0.0642*** (0.0138)	0.0805*** (0.0164)	0.1000*** (0.0269)	0.0119 (0.0108)
Family Type (if Nuclear= 1)	-0.0042 (0.0119)	-0.0137 (0.0134)	-0.0123 (0.0240)	0.0133 (0.0086)
Intercept	0.1695* (0.1392)	0.6211*** (0.0345)	0.7704*** (0.0563)	0.8202*** (0.0202)
R <sup>2</sup>	0.1531	0.1645	0.0985	0.0567
BP Test $\chi^2$ (p-value)	26.51*** (0.0000)	0.63 (0.4283)	54.79*** (0.0000)	7.05*** (0.0079)
F-Statistic (p-value)	25.91*** (0.000)	34.85*** (0.000)	13.82*** (0.000)	8.75*** (0.000)
N	1005	1005	1005	1005

Note: \* Shows significant at 1% while \*\* shows significant at 5% and \*\*\* shows significant at 10%. Standard Errors are reported in parentheses.

Female labor for participation is found to have positive effect on human security as its constituents. The coefficient is also statistically significant for human security, food security and economic security. Women's participation in the labor force boosts household income, improving consumption capability, and reinforcing economic stability. This added financial resource supports essential needs like food, shelter, healthcare, and children's education, thereby diminishing vulnerability to shocks. Moreover, by diversifying the sources of income within the household, women's employment reduces its vulnerability to economic



shocks such as job loss or fluctuations in the economy. This, in turn, contributes to greater resilience against poverty and strengthens the overall stability of the household's financial well-being. When women participate in the labor force, they contribute to the household income, which often results in greater purchasing power for food. This enables families to afford a wider variety of nutritious food items, essential for a balanced diet. This is evident from the positive and significant coefficient of female labor force participation for food security.

The role of female labor force participation in the relationship between household human security and climate change risk is examined by including the interaction between climate change risk and female labor force participation in the model. Women who contribute to household income not only manage resources effectively but also exhibit environmentally conscious behavior (Pérez et al., 2015; Mavisakalyan & Tarvedi, 2019; Kim, 2022). This contributes to reduced emissions (Wang & Zhang, 2020) and enhances household resilience to climate change through resource management (Dey et al., 2018). Research also indicates that female labor force participation encourages environmental sustainability and mitigates the impact of climate change by fostering adaptation and shielding households from economic shocks (Achuo et al., 2023; Md et al., 2022).

Our results depict that female headed households tend to have higher human security as compared to male headed households. Women develop strong coping strategies and are very resourceful when managing household resources. This adaptability is vital in traversing environmental shocks, which allows female headed households to sustain themselves more effectively (Fuller & Lain, 2020). Ardi, et al. (2022) establish that female headed households may engage in diverse livelihood strategies, which can hedge them against risk and reduce vulnerability. The diversification of livelihood act as the buffer against climate change risk leading to improvement in human security.

Indebtedness is also taken as a dummy variable taking a value 1 if the household is currently indebted. The results depict that indebted households generally experience lower levels of human security compared to those without debt. This is primarily due to economic liabilities that increase stress and reduce the household's resilience against economic or health-related shocks, thereby leading to worsening of human security outcomes. Further, the dummy for household head having a secondary occupation is also incorporated to assess whether more than one source of income improves human security of households. The coefficient of secondary occupation dummy has a positive sign as having a secondary occupation not only supplements the primary source of income improving the economic situation of the household but also insulates the household from unforeseen shocks. Family type is found to be statistically insignificant.

Our results are according to the expectations. The impact of climate change on human security consistently shows significant and negative effects. This vulnerability encompasses insecurities related to food, health, and economic stability. Studies by Ajaz & Majeed (2018), Babar et al. (2021), Das et al. (2020), Ahmad et al. (2016), Ali et al. (2017), and Ullah et al. (2018) underscore the detrimental impact of climate change on human security through various channels. Female labor force participation on the other hand exerts positive influence on human security. Women's engagement in the workforce significantly boosts household income, enhancing consumption capabilities and economic stability. Additionally, the interaction between climate change risk and female labor force participation highlights that women not only manage resources effectively but also demonstrate environmentally conscious behavior, leading to reduced emissions and enhanced household resilience to climate change impacts (Pérez et al., 2015; Mavisakalyan & Tarvedi, 2019; Kim, 2022; Wang & Zhang, 2020; Dey et al., 2018; Achuo et al., 2023; Md et al., 2022). This underscores the role of female labor force participation in promoting environmental sustainability and mitigating climate-related vulnerabilities for households.

## 5. CONCLUSION

Our study aims to evaluate the impact of climate change risk on household human security in selected districts of Punjab, Pakistan—namely, Rawalpindi, Lahore, Bahawalpur, and Sialkot—and to investigate whether female labor force participation enhances households' resilience against climate change risks. The regression analysis reveals that climate change poses a significant security risk, consistently lowering human security of households in our sample, whereas female labor force participation demonstrates a positive impact on human security. Women's participation in the workforce plays a crucial role in raising household income, which in turn enhances consumption capabilities and fosters economic stability. This improved financial standing not only supports better living conditions and access to healthcare and nutrition.

Furthermore, the economic empowerment of women has been linked to more resilient and adaptable households, as it diversifies income sources and reduces the vulnerability to shocks. Women who contribute to household income manage resources effectively and exhibit environmentally conscious behaviour, reducing emissions and enhancing household resilience to climate change (Pérez et al., 2015; Mavisakalyan & Tarvedi, 2019; Kim, 2022; Wang & Zhang, 2020; Dey et al., 2018). Overall, women's workforce engagement is a critical factor in achieving sustainable economic progress and societal well-being.

In conclusion, our study underscores the impact of climate change and female labor force participation on household human security in selected districts of Punjab, Pakistan. The findings highlight that climate change significantly threatens household security, necessitating effective mitigation strategies. Conversely, female labor force participation emerges as a potent factor in bolstering household resilience, improving financial stability, and fostering environmentally conscious practices. These insights emphasize the importance of integrating gender-focused economic policies to enhance household adaptability and resilience against climate change risks. Promoting female labor force participation not only advances gender equality but also contributes to broader sustainable development goals, ensuring a more secure and prosperous future.

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Table 3. Cross tabulation of Female Labor Force Participation &amp; Human Security

Human Security	Female Labor Force Participation		Total
	No	Yes	
Highly Insecure	133 (13.21%)	57 (5.66%)	190 (18.87%)
Moderately Secure	496 (49.26%)	238 (23.63%)	734 (72.89%)
Highly Secure	50 (4.97%)	33 (3.28%)	83 (8.24%)
Total	679 (67.43%)	328 (32.57%)	1007 (100%)
Kendall's Tau-b	0.0428**		
<i>Economic Security</i>			
Highly Insecure	146 (14.5%)	54 (5.36%)	200 (19.86%)
Moderately Secure	418 (41.51%)	199 (19.76%)	617 (61.27%)
Highly Secure	115 (11.42%)	75 (7.45%)	190 (18.87%)
Total	679 (67.43%)	328 (32.57%)	1007 (100%)
Kendall's Tau-b	0.079**		
<i>Food Security</i>			
Highly Insecure	146 (14.5%)	56 (5.56%)	202 (20.06)
Moderately Secure	38 (3.77%)	29 (2.88%)	67 (6.65%)
Highly Secure	495 (49.16%)	243 (24.13%)	738 (73.29%)
Total	679 (67.43%)	328 (32.57%)	1007 (100%)
Kendall's Tau-b	0.0218		
<i>Health Security Risk</i>			
Highly Insecure	77 (7.65%)	39 (3.87%)	116 (11.52%)
Moderately Secure	507 (50.35%)	254 (25.22%)	761 (75.57%)
Highly Secure	95 (9.43%)	35 (3.48%)	130 (12.91%)
Total	679 (67.43%)	328 (32.57%)	1007 (100%)
Kendall's Tau-b	-0.0359		