Humanities and Social Sciences Letters
2026 Vol. 14, No. 3, pp. 386-399
ISSN(e): 2312-4318
ISSN(p): 2312-5659
DOI: 10.18488/73.v14i3.5115

Non-communicable diseases and labor force participation in Turkiye: Socioeconomic implications from a recursive bivariate probit analysis

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Article History
Received: 27 November 2025
Revised: 18 March 2026
Accepted: 27 April 2026
Published: 21 August 2026

Keywords
Chronic diseases
Labor force participation
Labor market status
Ordinary least square
Probit
Recursive bivariate probit model.

ABSTRACT

The purpose of this study is to examine how chronic health conditions affect individuals' decisions and abilities to participate in the labor force in Türkiye in 2019. Using data from the Türkiye Health Survey (THS) conducted by the Turkish Statistical Institute (TURKSTAT), the analysis investigates the effects of chronic diseases on labor force participation. Since the presence of chronic health conditions is highly likely to be associated with the pandemic, we restrict our analysis to the pre-COVID period to cover the non-pandemic-related effects of poor health. Methodologically, the study employs Ordinary Least Squares (OLS) and Probit models, alongside a Recursive Bivariate Probit (RBVP) model to address potential endogeneity associated with chronic health conditions. The findings indicate that individuals aged 15–64 with at least one chronic condition are less likely to participate in the workforce. The results confirm the significant role of health in shaping labor market outcomes and underscore the need for policies supporting the employment of individuals with chronic conditions. In terms of policy implications, preventive measures can help reduce the number of individuals affected by non-communicable illnesses. Additionally, policies aimed at improving working conditions and providing targeted support for individuals with chronic illnesses could enhance workforce participation and overall economic productivity.

Contribution/Originality: This study contributes to the literature by adding a health indicator to explain labor force participation. It is one of the few studies investigating the relationship between non-communicable diseases and labor market attachment in Türkiye. The primary contribution is finding that poor health decreases individuals' labor supply.

1. INTRODUCTION

Chronic health conditions are defined as long-lasting (longer than 6 months) and non-communicable diseases caused by genetic, physiological, and behavioral factors (World Health Organization, 2025). Cardiovascular diseases, cancers, chronic respiratory disorders, and diabetes are the main types of negative health conditions. According to the World Health Organization (WHO), chronic diseases caused at least 43 million deaths worldwide in 2021. Of all these deaths, 73% occurred in low- and middle-income countries (World Health Organization, 2025). The statistics from WHO indicate that, despite increased lifespan due to medical advancements, adverse health conditions still significantly impact humans. Individuals' lives and non-communicable diseases are interconnected in various ways, leading to limitations across physical, social, psychological, and economic domains. Moreover, ongoing poor health may result in reduced daily activities, increased anxiety, emotional distress, and social isolation.

On the other hand, chronic illnesses are causing increasing financial strain on countries, regardless of their level of economic growth. Chronic health issues can have a range of negative impacts on economies, including reducing labor force participation through work absenteeism, disability, and early retirement. These conditions can also reduce individuals' physical and cognitive abilities, leading to decreased productivity and further economic losses (Webber & Bjelland, 2015). The growing prevalence of chronic diseases and their impacts on economies are a major concern, and effective policies and interventions are needed to address these challenges. As a result, we assume that the treatment and management of chronic diseases and their adverse effects are more challenging in developing countries than in developed countries.

According to the Turkish Statistical Institute (TurkStat) (2020), 55.72% of the working-age population experience at least one chronic disease, and 34% of these individuals report that their chronic diseases impact their daily activities as well. Furthermore, 31.53% of females and 18.43% of males evaluate that their chronic disease prevents them from participating in social activities. Primitive statistics suggest that non-communicable diseases negatively impact individuals' social and economic lives, with women appearing to be more affected in Türkiye.

International literature increasingly recognizes health-related factors as a crucial component of human capital, incorporating them into both empirical and theoretical frameworks (Bastida & Pagán, 2002; Brown, Pagán, & Bastida, 2005; Kahn, 1998; Tunceli et al., 2005; Wilson, 2001). Although existing papers in Türkiye also offer substantial research on the relationship between labor market status and disability, prior studies are confined to Turkish males (Oncel & Karaoglan, 2020; Öncel & Karaoğlan, 2022). However, this paper presents a gender-based comparison regarding negative health status and the decision to participate in the labor force. Studies, particularly those focusing on developed countries, typically discuss the link between negative health conditions and labor market preferences through two main channels. One focuses on disability and its impact on employment. The other examines the effect of major chronic diseases on labor force participation individually. A key contribution of this study is that it is the first in Turkish literature to provide evidence on the relationship between non-communicable diseases and labor market outcomes, considering not only major conditions but also rare diseases. By analyzing this relationship, the paper aims to address gaps in the existing literature in Türkiye and offer a better understanding of how non-communicable or chronic diseases affect the working-age population. The design of health indicators also differs from earlier studies that use clinically diagnosed illnesses and their restrictive effects on daily life. Instead, self-reported adverse health conditions lasting more than six months, along with related limitations in daily activities, are used as health indicators. Another contribution is its methodological approach, as it is the first to employ a recursive bivariate probit model to examine potential endogeneity between chronic diseases and labor market decisions. Previous domestic studies have used Propensity Score Matching and Difference-in-Differences methods. In this paper, the RBVP model was chosen because it allows modeling of simultaneous endogeneity.

2. LITERATURE

There is a significant body of literature that observes the relationship between health status and its implications for the labor market. Many studies have been published on this topic, providing a range of perspectives and insights into the impact of health on individuals' ability to participate in the labor force. These studies support the understanding of this association and the channels through which poor health can affect labor market outcomes. Here, prior studies are categorized into two headings: (a) those addressing disability and employment or labor force participation, (b) those evaluating the individual impacts of selected diseases on labor market outcomes. Given that efforts addressing this issue in the context of developing countries remain limited, a discussion at the country level is not considered appropriate.

In the literature of health economics, disability is defined as an impairment, a long-term health condition diagnosed by clinics that limits the daily activities of individuals. Johnson and Lambrinos (1985) emphasize the existence of wage discrimination against disabled females and males in the US. Using data from 1984, Baldwin and

Johnson (1994) analyze labor market discrimination against males with disabilities by distinguishing between handicapped and disabled impairments in the US as well. The findings reveal large differences in employment rates and hourly wages between handicapped and nondisabled males. Campolieti (2002) considers the association between the disability status of older Canadian men. The results indicate that disabled older Canadians experience unemployment more than their healthier counterparts. On the other hand, Mizunoya and Mitra (2013), using a logistic decomposition approach, find that individuals with disabilities exhibit significantly lower employment rates in developing countries. Unfortunately, in the case of Türkiye, studies are limited to only a few. Oncel and Karaoglan (2020) explain the association between labor market status and disability for Turkish males via Propensity Score Matching. Their findings are consistent with the existing literature, indicating that males with disabilities are more likely to experience unemployment compared to healthy males. Öncel and Karaoğlan (2022) also discuss the impact of policy reforms on the labor force status of Turkish males via regression discontinuity analysis. They estimate that policy reforms do not create any incentives for disabled males to participate in the labor force in Türkiye.

As noted at the outset of this section, the studies reviewed in the second part comprise self-perceived health status-based research drawn from both the international. Cardiovascular diseases, diabetes mellitus, respiratory illnesses, mental disorders, and cancer are the negative health conditions that are mostly studied in health and labor economics. Kahn (1998) focuses on the possible association between diabetes mellitus and labor market performance in the United States. The findings show that females with diabetes tend to increase their labor market participation, while males with the same disease have a slight decrease in labor market participation. This suggests that the impact of chronic diseases on labor market participation may differ across genders. Bastida and Pagán (2002) also studied the influence of diabetes on employment and earnings among Mexican Americans. Their findings indicate that diabetes does not significantly affect the earnings of male individuals but does reduce their employment propensity compared to non-diabetic males. Among females, diabetes is related to lower productivity and earnings. Wilson (2001) compares the prevalence of chronic health conditions and their negative impact on economic activity in South Korea and the United States. As a result, chronic diseases have a detrimental effect on economic activity in South Korea, but this effect is not high in the United States. By using the Health Survey for England, Morris (2007) estimates the impact of obesity on employment via propensity score matching, univariate probit, and IV regression with a recursive bivariate probit model. Results of each model display that obesity has a negative effect on employment. (Brown et al., 2005) and Tunceli et al. (2005) present a model that shows the relationship between productivity and diabetes. Their findings indicate that both women and men with diabetes are less likely to work compared to their counterparts without diabetes. Latif (2009) conducts a study that uses a recursive bivariate probit model to investigate the effect of diabetes on employment among Canadian males and females of working age. The study uses the recursive model to explain the possible endogeneity of diabetes, which may affect the results of the model. The findings of the study show that diabetes has a negative effect on female labor market performance. Among older Australians, Schofield, Shrestha, Passey, Earnest, and Fletcher (2008) investigate the association between chronic health conditions and employment via logistic regressions. The results support the negative impact of existing health conditions. Chen and Lin (2018) evaluate the effect of cardiovascular disease, cancer, and diabetes on employment among Taiwanese people via probit and multivariate probit models. The results of the study indicate that cancer has the strongest negative effect on employment among the three diseases. In the study of Zhang, Zhao, and Harris (2009), a detailed analysis of major health conditions such as diabetes, cardiovascular diseases, and mental health via a multivariate probit model. The results show that selected health conditions are negatively correlated with labor market status. Kwon, Myong, Kim, and Kim (2020) compare the employment rate of individuals with non-communicable diseases in Korea and the U.S. Using multivariate logistic regression, Koreans diagnosed with a chronic disease have a lower employment rate than their healthy Korean counterparts (Kwon et al., 2020). Qiao, Wang, and Guo (2021) explore the results of some specific chronic illnesses in the context of senile and pre-senile Chinese individuals and their labor force participation.

Using a multivariate model with five structural equations, the largest impact of illness is on pre-senile women in China.

As seen in existing literature, empirical studies on the relationship between health and labor market status generally focus on diagnosed or selected illnesses and disabilities, mainly conducted in developed countries and among male populations. However, within the context of non-communicable diseases, not only major conditions such as cardiovascular disease, mental illness, diabetes, and cancer, but also rarer conditions may significantly influence employment status. Using the RBVP model, which allows endogenous regressors, this paper aims to examine the potential negative relationship for both males and females with poor health among working-age individuals in Türkiye, a developing country.

3. MATERIALS AND METHODS

3.1. Data and Variables

To organize summary statistics and calibrate the econometric analysis of the study, the Türkiye Health Survey (THS) is employed, which is released by the Turkish Statistical Institute (TURKSTAT). The main aim of this survey is to gather health information of individuals that is important for development indicators and to fill gaps in current knowledge about health in Türkiye. It also provides information on daily activities, smoking and alcohol consumption, and the use of health services by persons over 15 years of age. The THS is available for the years 2008, 2010, 2012, 2014, 2016, 2019, and 2022. Since we would like to analyze the pre-COVID period, we ignore the 2022 wave of the data. It is known that COVID-19 impacts negative chronic conditions. On the other hand, the sample structure does not allow collecting the waves of the survey; because of that, we only use the 2019 wave for our analysis, which includes more recent information about respondents' health status. Table 1 presents the covariates related to labor force participation and chronic disease. They are also derived from the Türkiye Health Survey (THS) and include age, square root of age, marital and educational status, number of members living in the household, and the existence of children under 6 in the household. These variables are used as baseline covariates in the analysis, and their effects on labor force participation and chronic disease are estimated using the recursive bivariate probit model. A detailed description of each variable is provided below.

Table 1. Dependent variables and covariates used in the estimation.

Dependent Variables	Type of Variables	Description
LBF	Binary	=0, respondent out of the labor force (Base category) =1, respondent is in the labor force
CRNC	Binary	=0, respondent does not report chronic disease (Base category) =1, the respondent has at least one chronic disease, resulting in either severe limitations in daily activities or non-severe but still restricted daily activities
Control Variables		
AGE	Continuous	the respondent's age
AGE_S	Continuous	the respondent's square root of age
GENDER	Binary	=0, male (Base category) =1, female
M_STAT	Categorical	=0, respondent is single (Base category) =1, respondent is married =2, respondent is divorced or widowed
EDUC	Categorical	=0, respondent has a primary school education or no degree (Base category) =1, respondent has a medium education (Secondary or high school) =2, respondent has high education (University, master's, or doctorate)
HH_SIZE	Continuous	the number of members living in the household
CHILD	Binary	=0, no children aged 0 to 6 (Base category) =1, there are children aged 0 to 6 in the household

Note: Dependent variables and exogenous covariates are created by using the Türkiye Health Survey (THS) for the year 2019.

The primary outcome of the study is labor force participation status. The dependent variable is defined as a binary indicator that equals 1 if an individual is employed or working, and 0 otherwise. The main independent variable is having negative health conditions or not. The existence of negative health conditions (CRNC) is assessed using the combination of the following questions in the survey: "*Have you ever struggled with asthma, diabetes, stroke, hypertension, etc., in the last 12 months?*" About twenty-one different non-communicable diseases are listed in the survey, and respondents answer "*Yes*" or "*No*". To make a robustness check, we also evaluate the answer to the following question: "*What is the level of restrictions on your daily activities due to any health problem?*". Respondents select one of the following options: "*severely restricted,*" "*restricted but not severe,*" or "*not restricted.*" This question allows us to perform a robustness check and assess the accuracy of the results with different definitions of chronic disease, as medical diagnosis is not available in the dataset. If a respondent reports at least one chronic disease and experiences restricted daily activities due to this health condition, CRNC takes the value of 1; otherwise, it is coded as 0. Control variables include age, the square root of age, marital status, education levels, the number of people living in the same household, and having a child aged 0-5 years.

Figure 1 presents the self-reported general health status of working-age males and females across five categories. It also offers a gender comparison of reported health conditions. In general, Turkish individuals of working age report good health. The data suggest that women are more likely to evaluate their health as bad or very bad compared to men. For instance, while 4.25% of women describe their health as not good, this rate is only 2% among men. It is possible that this disparity reflects both existing health differences and gender-specific perceptions of health. Most of the questionnaire respondents classify their health as neither good nor bad, with roughly 30% of working-age individuals, regardless of gender, falling into this middle category.

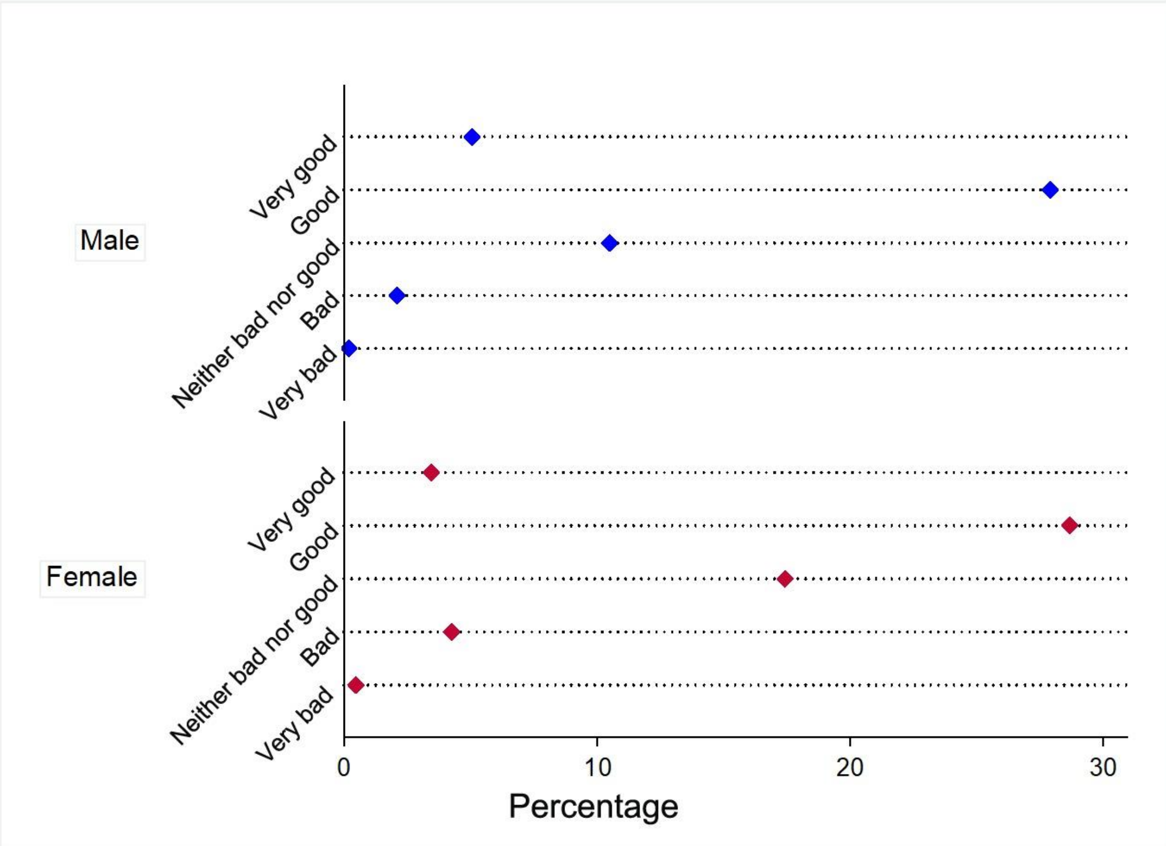

Figure 1. General health status by gender (%), 2019.

Note: Türkiye Health Survey (THS). Working–age population.

Figure 2 displays labor force participation of working-age males and females according to the general health status of the overall population. As expected, males predominantly participate in the labor force regardless of their health status. Seventy to eighty percent of males who evaluate their health as good and very good are in the labor force; however, thirty to thirty-five percent of females with good or very good health participate in the labor market. Among individuals in poor health, only ten percent of females are in the labor force, compared to thirty-five percent of males. When health status worsens, the likelihood of labor force participation declines more steeply for females compared to males.

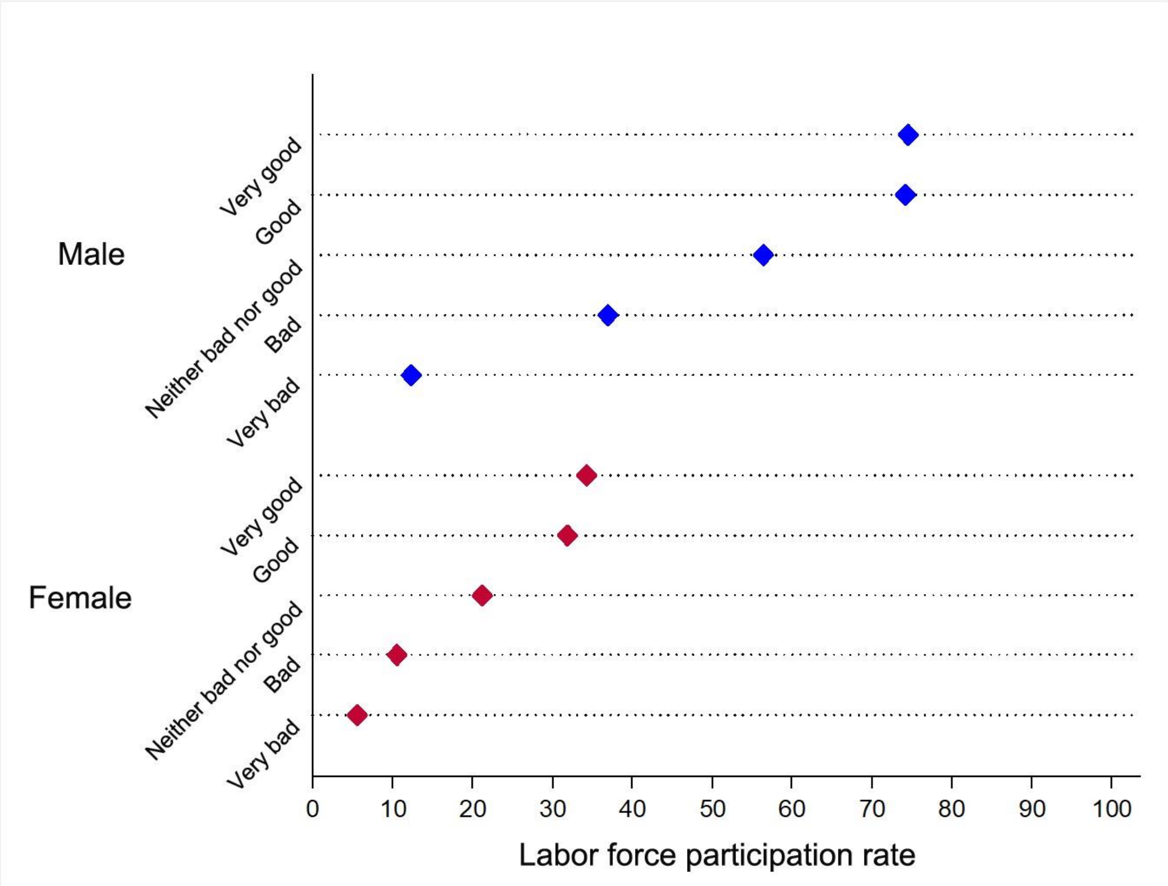

Figure 2. Labor Force participation by gender and general health status (%), 2019.

Note: Türkiye Health Survey (THS). Working–age population.

Table 2 represents the proportion of working-age people reporting one or more chronic conditions with daily restrictions in 2019. A summary of chronic health status and its impact on daily activities at different levels is provided for females and males in both the entire population and the working-age group. Half of the population reports at least one negative health condition. In 2019, 59.87% of working-age females and 44.81% of working-age males reported at least one chronic disease. The proportion of individuals with at least one adverse health condition and daily life restrictions is 22.80%. The number of females whose daily life is restricted by poor health is significantly higher compared to males in both populations. Additionally, 31.53% of Turkish women in the working-age group experience such restrictions.

Table 2. The share of respondents with at least one chronic disease, % (2019).

Population type	Self-Reported Chronic Disease			Self- Reported Chronic Disease & Affected Daily Activities in Different Levels		
Total Population						
	Yes	No	Total	Yes	No	Total
Female	50.74 (0.4985,0.5162)	49.26 (0.48370,0.5014)	100	28.66 (0.2786,0.2946)	71.34 (0.7053,0.7213)	100
Male	35.72 (0.3482,0.3662)	64.28 (0.6337,0.6517)	100	16.95 (0.1626,0.1766)	83.05 (0.8233,0.8373)	100
Working-Age Population						
	Yes	No	Total	Yes	No	Total
Female	59.87 (0.5878,0.6094)	40.13 (0.3905,0.4121)	100	31.53 (0.3051,0.3255)	68.47 (0.6744,0.6948)	100
Male	44.81 (0.4361,0.4600)	55.19 (0.5399,0.5638)	100	18.43 (0.1752,0.1937)	81.57 (0.8062,0.8247)	100

Note: Türkiye Health Survey (THS). Working–age population. Confidence intervals in parentheses.

Table 3 summarizes statistics for individuals with and without at least one chronic disease. The proportion of respondents with at least one chronic health problem participating in the labor force is lower than those without a chronic health problem. Females not participating in the labor force and with at least one chronic illness are considerably higher than healthy females. Specifically, 69.24% of these women report having at least one chronic health condition, while only 30.76% do not have any health problems. This suggests that, regardless of gender, individuals without chronic health conditions have better labor market indicators than those with chronic health conditions. They are more likely to participate in the labor force, work full-time, and have permanent employment. Overall, these results indicate that chronic diseases negatively affect labor market participation among Turkish individuals.

Table 3. Labor force statistics of individuals by their chronic diseases (%), 2019.

Labor Force Statistics	Respondent with chronic diseases		Respondent without chronic diseases	
	Female	Male	Female	Male
Labor Force Participation				
In the labor force	22.72 (0.2112,0.2440)	64.77 (0.6205,0.6739)	32.27 (0.3104,0.3352)	77.82 (0.7670,0.7890)
Out of the labor force	77.28 (0.7559,0.7887)	35.23 (0.3260,0.3794)	67.73 (0.6647,0.6895)	22.18 (0.2109, 0.2329)
Total Labor Force	100	100	100	100
Employment Type				
Full-time	84.28 (0.8084,0.8719)	95.73 (0.9391, 0.9701)	92.28 (0.9081,0.9352)	96.65 (0.9601,0.9718)
Part-time	15.72 (0.1280,0.1915)	4.27 (0.0298, 0.0608)	7.72 (0.0647,0.0918)	3.35 (0.0281,0.0398)
Total Employment Type	100	100	100	100
Employment Continuity				
Permanent	89.59 (0.8661,0.9196)	91.46 (0.8910,0.9334)	93.01 (0.9160,0.9419)	92.87 (0.9199,0.9365)
Temporary	10.41 (0.0803,0.1338)	8.54 (0.0665,0.1089)	6.99 (0.0634,0.0800)	7.13 (0.0580,0.0839)
Total Employment Continuity	100	100	100	100

Note: Türkiye Health Survey 2019 is used in the author's calculation. Working-age population (15-64). Confidence intervals in parentheses.

3.2. Methodology of Recursive Bivariate Probit Model and The Model

The Recursive Bivariate Probit model (RBVP) is a system of two probit equations that permits the error terms to be correlated, with a binary dependent choice in one equation potentially serving as an endogenous regressor in the other (Filippini, Greene, Kumar, & Martinez-Cruz, 2018). Additionally, a classic recursive bivariate probit model examines the treatment effect of a binary endogenous regressor on a binary outcome variable in the presence of unobservable factors (Marra & Radice, 2011). In simpler terms, this model is suitable when the outcome is dichotomous, and the dummy treatment variable is included in that outcome.

The model of the main outcome Y is:

$$Y^* = X_1'\beta_1 + X_2'\beta_2 + \epsilon_1 \qquad Y = 1\ if\ Y^* > 0, Y = 0\ otherwise \quad (1)$$

$$X_2 = X_1'\beta_1 + \epsilon_2 \qquad X_2 = 1\ if\ X_2^* > 0, X_2 = 0\ otherwise \quad (2)$$

Joint distribution of Y and X_2.

with $\begin{pmatrix}\epsilon_1\\ \epsilon_2\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}1 & \rho\\ \rho & 1\end{pmatrix}\right]$

The correlation between ϵ_1 and ϵ_2 causes endogeneity in the model, indicating that the error terms ϵ_1 and ϵ_2 may be correlated, which are able to change the results of the model. Additionally, the variables X_2 and Y are allowed to include the same covariates, so caution is needed when interpreting the results, as endogeneity and shared covariates may bias the estimated effects (Marra, Papageorgiou, & Radice, 2013).

Marginal effects of exogenous covariates include both the direct effects on the outcome itself and the indirect effects transmitted through the potentially endogenous treatment variable. This means that the impact of exogenous covariates on the outcome variable can be mediated through the treatment variable, which can affect the estimated effects of the covariates on the outcome (Hasebe, 2013). The direct marginal effect of a variable on the outcome is estimated using the coefficients in the outcome equation of the recursive bivariate probit model. To calculate the marginal effects of continuous variables, we need to follow the computation methodology described by Greene (2003).

$$ME = \frac{\partial Pr}{\partial\left(\frac{Y}{X_d}\right)} = \frac{\partial Pr}{\partial Y} + \frac{\partial Pr}{\partial X_d} \quad (3)$$

The first term of Equation 3 represents the direct effect of a continuous variable on the outcome variable, while the final term of the summation captures its indirect effect through the treatment variable. However, this computation method is not applicable to discrete covariates, as it is designed specifically for continuous variables. To estimate the marginal effects of discrete covariates, a different approach suitable for this type of variable should be followed. It involves using different estimation techniques or modeling the effects of the discrete covariates differently. Using Hasebe's (2013) methodology, marginal effect computation for discrete covariates is as follows:

$$ME = [\Pr\ |Y = 1 - \Pr\ |Y = 0] + [\Pr\ |X_2 = 1 - \Pr\ |X_2 = 0] \quad (4)$$

The first part of the formulation represents the direct effect of a variable on the outcome variable, while the second part represents the indirect effect of the variable via the treatment variable. The indirect marginal effect of a variable can be obtained by using the coefficient in the second equation of the recursive bivariate probit model (Hasebe, 2013). In the context of this study, the direct effect measures the impact of socio-economic and demographic variables on the probability of labor force participation through a direct association, while the indirect effect measures the impact of these variables on the probability of labor force participation through a change in individuals' health status. The total marginal effect of a variable is the sum of both the direct and indirect effects.

$$ATE = \frac{1}{n}\sum_{i=n}^{n} \emptyset\,(Y_i'\beta + \alpha) - \theta(Y_i'\beta) \quad (5)$$

As the main aim is to observe the association between treatment and the dependent variable, the RBVP model provides the formula for observing the effect of treatment outcome on the dependent variable, called the average treatment effect. It represents the difference between the marginal probability of outcome success given treatment success and the marginal probability of outcome success given treatment failure. In other words, it measures the average change in the expected outcome when the treatment variable changes from 0 to 1, holding other factors constant.

We specify a system of probit equations with a recursive structure to estimate the effect of poor health on labor force participation among Turkish people of working age. Let the *LBF** be a latent variable proportional to the propensity for labor force participation. The preference for labor force participation is modeled via a latent equation.

$$LBF^{*} = \beta_0 + \beta_1 age + \beta_2 age_{square} + \beta_3 educ_{stat} + \beta_4 marital_{stat} + \beta_5 child + \beta_6 household\_size + \gamma chronic_{disease} + \varepsilon_1 \qquad (6)$$

Where age, age squared, educational and marital status, having children, and the number of people living in the same household are exogenous covariates. Selected covariates represent demographic, socio-economic, and household structure-related variables. $Chronic_{disease}$ is the vector of treatment variables, chronic diseases. It is a dummy variable indicating the incidence of negative health conditions, with $chronic_{disease}=1$ for having at least one adverse health outcome and $chronic_{disease}=0$ otherwise.

$$CRNC^{*} = \beta_0 + \beta_1 age + \beta_2 age_{square} + \beta_3 educ_{stat} + \beta_4 marital_{stat} + \beta_5 child + \beta_6 househol_{size} + \varepsilon_2 \quad (7)$$

CRNC* is the latent variable for chronic diseases. The correlation between $\boldsymbol{\varepsilon}_1$ and $\boldsymbol{\varepsilon}_2$ causes endogeneity in the model, meaning that the error terms can change the results of the model. The second equation also incorporates the same set of covariates to maintain consistency across model specifications. In other words, the variables *CRNC* and *LBF* are allowed to include the same covariates, suggesting that care must be taken when interpreting the results, as endogeneity and common covariates may bias the estimated effects. We assume that socioeconomic and demographic variables can also explain the incidence of negative health conditions.

4. RESULTS

Table 4 reports the coefficient estimates obtained from the OLS, Probit, and Recursive Bivariate Probit (RBVP) models, respectively. In the RBVP model, the main (outcome) equation incorporates covariates expected to explain or affect the probability of labor force participation, including age, marital status, education level, household size, the presence of children aged 0–6, and chronic disease status. Moreover, age, its squared term, and educational status are included to explain respondents' health status. In other words, the same set of covariates explains labor force participation decisions conditional on adverse health status.

We observe a significant negative correlation between labor force participation and having at least one chronic disease and its restriction. A statistically significant negative effect is consistently observed across all model specifications. Furthermore, the effect becomes stronger when moving from the OLS to the RBVP model, suggesting that accounting for endogeneity amplifies the estimated impact. As expected, while age is positively significant, its square root is negatively correlated with the labor force participation decision of Turkish people. Moreover, Turkish females are less likely to be in the labor force compared to males. On the other hand, in the second equation of the RBVP model, females are more likely to report adverse health outcomes. Surprisingly, increasing the number of children under 6 in the household leads to a decrease in the probability of labor force participation. Results associated with this variable should be interpreted by accounting for gender effects, as we hypothesize a significant difference between male and female household heads. Having a secondary or high school diploma and university or higher education exhibit positive and significant results in RBVP. In contrast, the OLS and probit estimation results reveal a negative association with medium education. Each category of marital status is statistically significant and negatively correlated with being in the labor force compared to single individuals in RBVP. However, being married as independent covariates is not sufficient to explain chronic diseases.

In the second equation of the RBVP model, whose dependent variable indicates having at least one chronic disease and its daily restriction, age has a positive and significant effect on chronic disease, meaning that as age increases, the incidence of chronic disease increases. Gender difference is observed as statistically significant, suggesting that the probability of reporting adverse health conditions and limited daily routines due to illness is higher in females than in males. As expected, the prevalence of chronic conditions decreases with higher education levels. At the end of the table, the rho (ρ) coefficient, which indicates the joint probability of error terms, justifies that labor force participation among working-aged people and their chronic diseases are correlated.

Table 4. Coefficient estimation results.

Variables	OLS	Probit Model	RBVP Model	
			Main Equation (Dep. Var.LBF)	Second Equation (Dep. Var. CRNC)
CRNC	-0.1304*** (0.0093)	-0.2040*** (0.0304)	-0.6069*** (0.0982)	-
AGE	0.0782*** (-0.0017)	0.2304*** (0.0065)	0.2269*** (0.0067)	0.0452*** (0.0074)
AGE_S	-0.0009 (0.0000)	-0.0028**** (0.0000)	-0.0027*** (0.0000)	-0.0001** (0.0001)
GENDER				
Female	-0.4504*** (0.0067)	-1.5079*** (0.0277)	-1.444*** (0.0332)	0.4049*** (0.0252)
EDUC				
Medium Educ.	-0.0197*** (0.0079)	-0.5794*** (0.0450)	0.0642** (0.0277)	-0.2969*** (0.0289)
Higher Educ.	0.2353*** (-0.0093)	0.6955*** (0.0630)	0.7521*** (0.0374)	-0.4146*** (0.0349)
M_STAT				
Married	-0.872*** (0.0118)	0.1124*** (0.0260)	-0.5593*** (0.0448)	0.0673 (0.0493)
Divorced/Widowed	-0.0181 (0.0182)	0.8321 (0.0329)	-0.6333*** (0.0639)	0.2704*** (0.0636)
HH_SIZE	-0.0010 (0.0023)	0.0106 (0.0081)	0.0118 (0.0080)	0.0080 (0.0088)
CHILD (Yes)	-0.0397*** (0.0086)	-0.0693*** (0.0313)	-0.0768** (0.0311)	-0.0618* (0.0343)
Constant	-0.4181*** (0.0329)	-3.368*** (0.1300)	-3.7284*** (0.1203)	-2.0909*** (0.1360)
Rho (ρ)	-	-	0.0610**	
Number of obs.	14,626	14,626	14,626	

Note: Türkiye Health Survey 2019 and author calculation. Robust standard errors are given in parentheses. And ***p < 0.01, **p < 0.05 and *p < 0.1.

Table 5 reports a comparison of the marginal effects from both models, evaluated at the means of all explanatory variables. Since the direct marginal effect of the endogenous treatment variable is not defined in the RBVP framework, it is not available for CRNC. However, we report the Average Treatment Effect (ATE), which provides the correct causal marginal effect of treatment in Table 6. ATE indicates the effect of a discrete change in treatment, holding all other observed and unobserved variables constant (Coban, 2022). Accordingly, we prefer to assess it as a distinct measure in the following table. Methodologically, the model offers different marginal effects regarding covariates, except for the treatment variable. Additionally, three different marginal effects are reported. The direct marginal effect captures the impact of the covariates on labor force participation, whereas the indirect marginal effect reflects the influence of selected explanatory variables on the main outcome (*LFP*) through the channel of adverse health conditions. Turkish females are 5.4% and 5.8% less likely to participate in the labor force, according to the probit and RBVP model estimates, respectively. In both models, a medium level of education decreases the likelihood of labor force participation; however, the effect is relatively small in the RBVP model. Conversely, individuals with higher education levels exhibit the highest participation rates compared to those with low or medium education. For example, people with university or higher education exhibit 3 and 1 percent greater engagement in the labor market, respectively. Moreover, variables age and age square provide useful information for estimating the impact of aging on the labor market. As age increases, the probability of being in the labor market increases. Whereas at older ages, the likelihood starts to decrease, indicating that age exhibits an inverse U-shaped pattern. According to the probit model, having a negative health condition with varying levels of restriction decreases the probability of being in the labor force by 8 percent.

Table 5. Marginal effects of probit & recursive bivariate probit model.

Variables	Probit Model	RBVP MODEL		
		Direct marginal effect	Indirect marginal effect	Total marginal effect
CRNC	-0.0812*** (0.01213)	-	-	-
AGE	0.1041*** (0.0030)	0.0126*** (0.0007)	0.0052*** (0.0007)	0.0178*** (0.0100)
AGE_S	-0.0013*** (0.0000)	-0.0002*** (0.0000)	-0.0000* (0.0000)	-0.0002*** (0.0000)
GENDER				
Female	-0.5465*** (0.0083)	-0.1101*** (0.0022)	0.0467*** (0.0031)	-0.0578*** (0.0039)
EDUC				
Medium Educ.	-0.0343*** (0.0111)	0.0026 (0.0033)	-0.0165*** (0.0029)	-0.0091** (0.0039)
Higher Educ.	0.3119*** (0.0122)	0.1141*** (0.0056)	-0.0249*** (0.0040)	0.0705*** (0.0082)
M_STAT				
Married	-0.1212*** (0.0187)	-0.0208*** (0.0032)	0.0003 (0.0043)	-0.0373*** (0.0088)
Divorced/Widowed	-0.0403 (0.0277)	-0.0169** (0.0076)	0.0058 (0.0054)	-0.0107 (0.0011)
HH-SIZE	-0.0032 (0.0035)	-0.0004*** (0.0005)	-0.0009 (0.0007)	-0.0013 (0.0011)
CHILD Yes	-0.0562*** (0.0129)	-0.0094*** (0.0020)	-0.0052** (0.0029)	-0.0146*** (0.0040)

Note: Türkiye Health Survey 2019 and author calculation. Robust standard errors are given in parentheses. And ***p < 0.01, **p < 0.05 and *p < 0.1.

In Table 6, the average treatment effect (ATE), average treatment effect on the treated (ATET), and average treatment effect on the conditional probability (ATEC) are presented. All treatment effect estimates are statistically significant, indicating that impaired health has a negative effect on the labor force participation of the working-age population. In other words, the average effect of the treatment variable (negative health outcomes) on the outcome (labor force market status) is negative. For example, according to ATE, individuals aged 15-64 with at least one chronic disease are 15.8% less likely to participate in active work life. ATEC and ATET also show that this effect is 4.81% and 15.7%, respectively.

Table 6. Average treatment effects.

ATE	-0.1585*** (0.0268)
ATEC	-0.0481*** (0.0082)
ATET	-0.1571*** (0.0258)

Note: Türkiye Health Survey 2019 and author calculation. Robust standard errors are given in parentheses. And ***p < 0.01.

5. CONCLUSION

This paper employs a recursive bivariate probit model to estimate the negative effect of illness on labor force participation for working-age Turkish individuals, using data from the Türkiye Health Survey, which is representative. The model specification considers the existence of potential endogeneity arising from health-related conditions. We assume that self-perceived health conditions may include measurement errors, as people tend to report their health status worse than it actually is. The RBVP model shows that treating negative conditions as exogenous may lead to overestimation or underestimation in the model. It adjusts for endogeneity both in the direct effect of socio-economic factors on labor force participation and the indirect effect through negative health conditions. By doing this, the model produces estimates of the total effects that differ from those obtained through a simpler single-equation approach. It is a system of two probit equations that permits the error terms to be correlated, and the binary dependent variable in one equation can be an endogenous regressor in the other equation (Filippini et al., 2018). In this study, the dependent variable in the outcome equation is labor force participation, and having one or more chronic health conditions is both the dependent variable of the second equation and a potentially endogenous variable in the first equation. In addition to the endogenous covariate, demographic and socio-economic explanatory variables such as age, education level, and marital status are included in the models. This paper is among the first to use the RBVP model as an empirical strategy to explore the relationship between self-perceived health and labor supply. Another key contribution is that it moves beyond a male-centered analytical perspective by explicitly presenting results for females, thereby offering pioneering evidence in this context.

The study population consists of 23,199 individuals, with 14,626 in the working-age population. Among them, 5,367 report having one or more chronic diseases, and due to negative health conditions, their daily life is severely affected or restricted, even if not severely. On the other hand, individuals with poor health and varying levels of daily activity limitations constitute 23 percent of the total population. This share is slightly higher among the working-age population, reaching 25 percent. Notably, women with at least one non-communicable disease are twice as numerous as men. These figures underscore the importance of investigating the labor market challenges faced by individuals with chronic diseases.

Both statistical and empirical results from this study indicate that having chronic diseases, coupled with varying levels of daily life limitations, reduces the preference for being in the labor force. The findings indicate that individuals with chronic diseases are significantly less likely to participate in the labor force compared to their healthier counterparts. Moreover, women report chronic health problems more frequently than men, which further highlights gender differences in labor market outcomes. We have shown that the impact of illness on the probability of labor force participation varies significantly by gender.

The study contributes to the literature by being the first to analyze the labor market behavior of the working-age population with chronic health conditions in Türkiye. It develops that co-morbidity is an important determinant of labor market outcomes. The results underline the importance of considering health limitations when designing labor market and social policies.

It should be noted that these findings underline the necessity of integrated policy implications rather than isolated interventions in both health and labor market. For example, it will be useful to plan applying preventative and primary health care strategies for working-aged people with non-communicable diseases. Moreover, to design more targeted and effective interventions, health monitoring systems should be strengthened. Rather than focusing solely on male employment, policy implications should encompass both females and males.

As discussed in the literature review, previous studies provide valuable insights into the relationship between specific chronic conditions and employment. However, further research is required, particularly in the context of labor force participation and health limitations.

With more detailed data, it would be possible to identify specific diseases such as diabetes, cancer, and cardiovascular illnesses and to assess their unique impacts on labor market outcomes. Given the scope of this study, we focus on overall reported non-communicable diseases as a single variable, rather than disaggregating by disease type. Future research could examine specific chronic diseases and their individual effects on labor force participation in Türkiye, which may, in turn, enable the development of more targeted policy implications.

Funding: The author received no financial support for the research, authorship, and/or publication of this article.
Institutional Review Board Statement: This study utilizes secondary data from the Türkiye Health Survey (THS) 2019 conducted by TURKSTAT. The dataset is publicly available and anonymized. As the study does not involve human subjects directly, clinical data, or identifiable personal information, ethical approval and an IRB protocol number are not applicable.
Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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