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Determination of the Relationship Between Low Back Pain and Risk Factors in Türkiye Using a Population-Based Multilevel Cross-Sectional Dataset

Türkiye'de Bel Ağrısı ile Risk Faktörleri Arasındaki İlişkinin Popülasyona Dayalı Çok Düzeyli Kesitsel Veri Setinin Kullanılarak Belirlenmesi

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ABSTRACT Objective: Low back pain (LBP) is a prevalent and debilitating condition that impacts people of all ages, significantly reducing their quality of life and mobility. This study explores the relationship between LBP and various factors, including demographics, socioeconomics, and psychological aspects, using a national-level survey of family members in Türkiye. **Material and Methods:** Analysis utilized a multilevel population-based cross-sectional dataset from the Turkish Household Health Survey by the Turkish Statistical Institute. The study included 8,166 families and 17,084 individuals aged 18 and above. A random-effects probit model accounted for familial heterogeneity to examine LBP prevalence and risk factors. **Results:** Approximately 31.9% of participants reported experiencing LBP in the previous year. Several individual and family characteristics were linked to LBP, including female gender, marriage, advancing age, higher weight, smoking, alcohol use, low education, low income, fewer children, physically demanding work, history of diseases, hypertension, and low fruit consumption. Depression had twice the impact on LBP risk compared to hypertension. **Conclusion:** This study sheds light on diverse factors influencing LBP in Türkiye, which should inform preventive and treatment strategies. For example, considering LBP's multifaceted nature and susceptibility to age-related changes, healthcare providers should prioritize innovative imaging techniques for precise diagnosis. Such technologies can offer valuable insights into the root causes of pain and expedite clinical decisions.

Keywords: Depression; low back pain; obesity; probit model; risk factors

ÖZET Amaç: Bel ağrısı [low back pain (LBP)] insanların yaşlarına bakılmaksızın hayatlarını önemli ölçüde etkileyen yaygın ve engelleyici bir durum olup yaşam kalitesini ve hareketliliği önemli ölçüde azaltır. Bu çalışma, Türkiye'de ulusal düzey aile bireyleri anketi kullanarak LBP ile demografik, sosyoekonomik ve psikolojik faktörler dahil olmak üzere çeşitli faktörler arasındaki ilişkiyi araştırmaktadır. **Gereç ve Yöntemler:** Analiz, Türkiye İstatistik Kurumu tarafından Türkiye Hanehalkı Sağlık Araştırması'ndan elde edilen çok seviyeli nüfus temelli kesitsel veri setini kullanmıştır. Çalışma, 18 yaş ve üzeri 8,166 aile ve 17,084 bireyi içermiştir. Aileye özgü farklılıkları dikkate alan rasgele etkiler probit modeli, LBP yaygınlığını ve risk faktörlerini incelemek için kullanılmıştır. **Bulgular:** Katılımcıların yaklaşık %31.9'u bir önceki yıl içinde LBP yaşadıklarını rapor etmiştir. LBP ile ilişkilendirilen birçok bireysel ve aile özelliği bulunmaktadır, bunlar arasında kadın cinsiyet, evlilik, ilerleyen yaş, yüksek kilo, sigara içme, alkol kullanma, düşük eğitim, düşük gelir, az çocuk, fiziksel olarak zorlayıcı iş, hastalık öyküsü, hipertansiyon ve az meyve tüketimi yer almaktadır. Depresyon, hipertansiyona göre LBP riski üzerinde iki kat etki yapmıştır. **Sonuç:** Bu çalışma, Türkiye'de LBP'yi etkileyen çeşitli faktörler hakkında bilgi sunmaktadır ve bu bilgi, önleyici ve tedavi stratejilerini bilgilendirmelidir. Örneğin, LBP'nın çok yönlü yapısı ve yaşa bağlı değişikliklere duyarlılığı göz önüne alındığında, sağlık hizmeti sağlayıcıları kesin teşhis için yenilikçi görüntüleme tekniklerine öncelik vermelidir. Bu tür teknolojiler, ağrının kök nedenleri hakkında değerli içgörüler sunabilir ve klinik kararlarının hızlandırılmasına yardımcı olabilir.

Anahtar Kelimeler: Depresyon; bel ağrısı; obezite; probit model; risk faktörleri

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Low back pain (LBP) is a prevalent and debilitating condition that impacts people of all ages, significantly reducing their quality of life and mobility. It is a common musculoskeletal disorder, affecting approximately 70% to 84% of individuals at some point in their lives, including children.[1-7] Despite advancements in treatment modalities and technology, LBP remains a global concern due to its high prevalence and substantial economic costs, including in Türkiye.[4,5,8-12]

However, there is a lack of consensus among studies regarding the prevalence and incidence of LBP. For instance, systematic reviews have reported varying figures, with mean lifetime, annual, and point LBP incidences ranging from 38.0% to 38.9% and 18.3%, respectively, while individual cross-sectional studies have reported point and lifetime prevalence values of 70% and 80%.[6,13,14] These discrepancies arise because systematic reviews often encompass diverse field studies, including those focusing on various occupations. In contrast, Türkiye exhibits a higher estimated LBP prevalence, ranging from 44% to 79% during a lifetime, with corresponding point and annual prevalence values approximately between 19.7% and 20.1% and 35.99%, respectively.[15,16] Surprisingly, there is a dearth of comprehensive reviews or meta-analyses reporting LBP prevalence specific to Türkiye, although a large cross-sectional individual study published in 2006 found lifetime, 12-month period, and point prevalence rates of 44.1%, 34.0%, and 19.7%, respectively.[17]

Beyond its physical toll, LBP carries significant social and economic costs, including direct expenses like insurance and compensation, as well as indirect costs such as sick leave and reduced productivity.[6,7,9,12,18,19] In the United States of America (USA), around 75% of direct and indirect costs related to back pain are attributed to patients with persistent pain, resulting in an annual cost exceeding $100 billion.[20,21] The total medical costs in the USA, including back pain and pain-related labor productivity losses, have soared to $635 billion annually.[22,23] In Türkiye, the annual cost of exposure to LBP is approximately 2 billion Turkish liras (TL).[15]

The incidence of LBP is influenced by a complex interaction of biophysical, psychological, sociodemographic, and economic factors, affecting functionality, social participation, and personal financial well-being.[9] Research over the past two decades has provided valuable insights into these factors. However, the multifactorial nature of LBP prevalence continues to pose challenges. Furthermore, the rise in static ergonomic working environments globally, particularly in emerging economies like Türkiye, is expected to lead to a substantial increase in LBP complaints and related costs to communities.

Notably, no studies have considered the cluster- or family member-specific multilevel nature of data in a population-based cross-section, exploring the existence of silent driver forces, such as individual and family-specific risk exposures, that shape the persistent prevalence of LBP at the country scale. Additionally, family-induced heterogeneity at the family level has not been adequately accounted for. To fill this gap, the current study utilizes a rich population-based cross-sectional dataset and a wide range of risk factors to investigate the incidence of LBP in Türkiye while controlling for family-induced heterogeneity. The study employs the random effects probit model, widely used in health sciences literature, to address family-specific unobserved heterogeneity among individuals within a family in Türkiye.[24,25] This study, focused on Türkiye, contributes to our understanding of the multifactorial nature of LBP and its effects on families and communities. It provides valuable insights for addressing this health issue and developing effective prevention and management strategies, aiming to create more dynamic and efficient work and health programs across the country.

MATERIAL AND METHODS

ETHICS APPROVAL AND DATA COLLECTION

This study received approval from both the Turkish Statistical Institute (TSI) under authorization number 23.08.2019/19496 and the Atatürk University Ethics Committee of the College of Medicine with approval number of 26.12.2019/556 (date: March 25, 2021). It adhered to the principles outlined in the Declaration of Helsinki.

DATA COLLECTION AND PARTICIPANTS

The study employed cross-sectional data from the latest national health survey conducted by the TSI. The Türkiye Health Survey has been conducted biennially since 2008, in collaboration with the Statistical Office of the European Union (SOEU). Surveys took place during the final three months of the year (October, November, and December) to collect multilevel (i.e., family members) cross-sectional data by monthly division, aligned with SOEU's questionnaire modules.

Before data collection, 9,470 household addresses were selected as the total sample size. Of these, 8,325 families were successfully interviewed, resulting in an 88% participation rate. Analysis included individuals aged 18 and above within each family, totaling 8,166 families (clusters) and 17,084 individuals (subjects). The dependent variable focused on whether individuals had experienced lumbar complaints within the last 12 months of 2019. The question was phrased as "In the last 12 months, have you encountered any issues in your lumbar region such as LBP, lumbar disc hernia, or other lumbar defects?". It encompassed both mechanical issues and diseases affecting the lumbar region.

INDEPENDENT VARIABLES

The study considered a wide array of independent variables, from individual characteristics (i.e., gender, age, marital status, education, employment, body mass index, health insurance, sports, occupation, tobacco, alcohol, walking, sports duration, diet, depression, hypertension history) to family clustering traits (children under six, income, family structure, and Nomenclature of Territorial Units for Statistics regions). Descriptive statistics for these traits are in Table 1, with comprehensive explanations. No multicollinearity was observed among them, as indicated by the variance inflation factor (VIF) in Table 1.

STATISTICAL ANALYSES

The study analyzed LBP exposure as the dependent variable and risk factors as independent variables. Repeated measurements occurred among individuals within families, resulting in an unbalanced panel structure. To address such a problem, the random-effects probit model was employed. The model accounts for repeated family unit sampling at each risk factor level, classifying them based on LBP presence. It effectively controls for unobserved heterogeneity, particularly within families, where differences in attitudes and abilities among family members exist. Heterogeneity between families is inevitable due to diverse unobservable factors. For instance, hereditary transmission of exposure and shared occupational activities can vary within families. Furthermore, a family's LBP history can influence family members' attitudes. Ignoring such a multilevel relationship can jeopardize statistical parameter properties.

RESULTS

The survey results reveal that approximately one-third (31.9%) of the surveyed individuals reported experiencing Lower Back Pain (LBP) (Table 1). Additionally, the data indicates that at least one member of 4,232 out of 8,166 families had experienced LBP, implying that LBP affected one in every two families (51.82%). This prevalence rate surpasses those reported in developed Western societies such as Australia (25.6%), Canada (28.7%), the United Kingdom (36.1%), and Sweden (39.2%).[14] For a more detailed analysis of the data, readers are encouraged to consult Table 1, which contains mean values for key regressors.

Examining the demographics, it is evident that 46% of the respondents were male, with individuals aged over 64 constituting approximately 15% of the sample. Moreover, 69% of the participants were married, while 19% and 18% were high school and university graduates, respectively. In terms of occupation, about 38% were actively employed, while 14% were retired. Furthermore, roughly 42% of the respondents had a normal weight, while morbidly obese individuals accounted for approximately 6%. Regarding physical activity, 17% engaged in daily walks exceeding an hour, while 64% predominantly engaged in sedentary or standing work. Smoking was prevalent among approximately 46% of respondents, whereas alcohol consumption was relatively low, at around 5%. One-tenth of individuals reported experiencing depression, while hypertension affected approximately 19%. Additionally, about 16% of families were classified as

TABLE 1: Descriptive statistics of variables.

Variables	Variable description	% Frequency ($\bar{X}$±SD)	VIF
Dependent variable			
Low back pain prevalence	1 if the individual reported having low back pain in the last 12 months during the survey time in 2016, 0 otherwise	31.9±46.6	
Explanatory variables:			
A: Individual traits:			
Gender	1 if the individual is male, 0 otherwise	45.6±49.8	1.982
Age classification:			
Age <30 years	1 if the individual is less than 30 years old, 0 otherwise (ref. group)	24.5±43.0	——
Age 30-44 years	1 if the individual is between 30-44 years old, 0 otherwise	29.3±45.5	2.742
Age 45-64 years	1 if the individual is between 45-64 years old, 0 otherwise	31.8±46.0	4.019
Age >64 years	1 if the individual is older than 64 years, 0 otherwise	14.4±35.1	3.837
Marital status:			
Unmarried	1 if the individual is never married	21.1±40.8	4.663
Married	1 if the individual is married, 0 otherwise	68.6±46.4	3.686
Other marital status	1 if the other marital status (e.g., divorced or widow) is present, 0 otherwise (ref. group)	10.2±30.3	——
Education levels:			
No school	1 if the individual has no school diploma, 0 otherwise (ref. group)	12.8±33.5	——
Elementary school	1 if the individual has an elementary school diploma, 0 otherwise	33.0±47.0	2.901
Secondary school	1 if the individual has a secondary school diploma, 0 otherwise	17.4±37.9	2.772
High school	1 if the individual has a high school diploma, 0 otherwise	19.0±39.2	2.882
College	1 if the individual has a college degree including a master's and doctorate, 0 otherwise	18.0±38.4	3.121
Employment types:			
Working	1 if the individual currently works, 0 otherwise	38.2±48.6	2.480
Job seeking	1 if the individual seeks a job (unemployed), 0 otherwise	13.5±34.2	2.224
Retired	1 if the individual is retired, 0 otherwise	14.3±35.0	2.015
Other employment types	1 if the individual is disabled, a housewife, a housekeeper, and a compulsory military servant (ref. group):	34.0±47.4	——
BMI classification:			
Normal weight	1 if BMI≤25 (reference group)	41.9±49.4	——
Overweight	1 if BMI>25 and BMI≤30, 0 otherwise	35.8±47.9	1.337
Obese	1 if BMI>30 and BMI≤35, 0 otherwise	16.5±37.1	1.333
Over obese	1 if BMI>35, 0 otherwise	5.8±23.5	1.187
Health insurance types:			
Social security coverage	1 if treatment costs are covered by the state, 0 otherwise	9.2±27.0	1.064
Private health insurance	1 if treatment costs are covered by the private health insurance company, otherwise 0	3.7±19.0	1.112
Different sports activities:			
Walking time	1 if the individual walks more than an hour a day, 0 otherwise	16.8±37.4	1.068
Sports	1 if the individual devotes to sports and fitness activities in a week, o otherwise	8.0±27.1	1.100
Resting	1 if the person is resting for less than four hours a day, otherwise 0	35.6±47.9	1.096
Job classification:			
Sitting job	1 if the individual works mostly in a sitting or standing job, 0 otherwise (ref. group)	63.6±48.1	——
Moderate job	1 if the individual works mostly in walking or a moderately physically demanding job, 0 otherwise	32.3±46.8	1.135
Heavy physical work	1 if the individual often does heavy and physically demanding work, 0 otherwise	4.0±19.6	1.333
Tobacco and alcohol behavior:			
Tobacco	1 if the individual smokes, 0 otherwise	45.8±49.8	1.326
Alcohol	1 if the individual smokes, 0 otherwise	5.1±21.9	1.044
Fruits, vegetables, 100% fruit juices, and carbonated drinks behavior:			
Fruit consumption	1 if the individual consumes one or more servings of fruit a day, 0 otherwise	90.6±29.2	1.195
Vegetable consumption	1 if the individual consumes one or more servings of vegetables a day, 0 otherwise	96.0±19.5	1.178
Fruit juice	1 if the individual consumes 100% juice once or more per day, 0 otherwise	24.8±43.2	1.062
Soft drink	1 if the person consumes one or more sugary soft drinks such as lemonade and cola per day, 0 otherwise	35.8±47.9	1.162
Some illness history:			
Depression	1 if the individual is diagnosed with depression, 0 otherwise	10.0±29.9	1.062
Hypertension	1 if the individual is diagnosed with hypertension, 0 otherwise	18.5±38.9	1.372

TABLE 1: Descriptive statistics of variables *(contunied)*.

Variables	Variable description	% Frequency (X̄±SD)	VIF
B: Family traits:			
Number of kids	The number of children between the ages of 0-6 in a family	0.34±0.67	1.416
Income groups:			
Income ≤3,398 TL	1 if the household income is less than 3,398 TL, 0 otherwise (reference group)	48.0±50.0	—
Income 3,398-6,890 TL	1 if the household income is between 3,398-6,890 TL, 0 otherwise	35.9±48.0	1.305
Income >6,890 TL	1 if the household income is greater than 6,890 TL, 0 otherwise	16.1±36.8	1.513
Family types:			
Spouses only	A family consisting of only spouses	7.5±26.9	1.362
Spouses with kids	A family consisting of spouses and kids	17.2±37.7	1.313
Other family types	At least one nuclear family and other members or more than one members without a nuclear family (ref. group)	75.3±43.2	—
Regions:			
İstanbul	1 if the individual resides in İstanbul, 0 otherwise	13.0±33.7	2.473
Western Marmara	1 if the individual lives in the western Marmara region, 0 otherwise	10.8±31.0	2.273
Eastern Marmara	1 if the individual resides in the eastern Marmara region, 0 otherwise	4.6±21.0	1.595
Aegean	1 if the individual resides in the Aegean region, 0 otherwise	5.5±22.8	1.697
Mediterranean	1 if the individual resides in the Mediterranean region, 0 otherwise	10.1±30.1	2.218
Western Anatolia	1 if the individual resides in the western Anatolia region, 0 otherwise	2.3±14.9	1.309
Central Anatolia	1 if the individual resides in the central Anatolia region, 0 otherwise	13.9±34.6	2.610
Western Black Sea	1 if the individual resides in the western Black Sea region, 0 otherwise	7.1±25.7	1.908
Eastern Black Sea	1 if the individual resides in the eastern Black Sea region, 0 otherwise	21.3±41.0	3.278
Southeastern Anatolia	1 if the individual resides in the southeastern Anatolia region, 0 otherwise	4.2±20.1	1.531
Northeastern Anatolia	1 if the individual resides in the northeastern Anatolia region, 0 otherwise (ref. group)	7.2±25.9	—
The total number of households:		8,325	
The total number of individuals:		17,084	

SD: Standard deviation; VIF: Variance inflation factor, and ref. group stands for the reference group; BMI: Body mass index.

high-income, 13% resided in İstanbul, and 10% lived in the Mediterranean region.

Parameter estimates, including rho, as a scale estimate for family-induced heterogeneity, were derived using maximum likelihood estimation and are presented in Table 2. The outcomes align generally with our expectations. Prior to exploring the effects of explanatory variables (trait exposures) on LBP prevalence, given our extensive dataset, we assessed the association between covariates and LBP prevalence using likelihood ratio (LR) statistics. The combined impact of individual and family-related traits was found to be statistically significant in determining LBP prevalence [LR=2470.98, degrees of freedom (df)=46, and $p<0.000$]. Furthermore, the random-effects probit model proved statistically significant and more compatible with the data (LR=118.22, df=1, and $p<0.000$), as it accounted for the heterogeneity among family members by transforming it into a scale value, thus ensuring the parameters' unbiasedness, consistency, and efficiency.

Given the nonlinear nature of LBP prevalence, we analyzed the qualitative effects of risk factors using marginal effects. A comprehensive overview of marginal effects, including their distinctions from odds ratios, is presented in Table 2 for those interested. Subsequently, we will focus on statistically significant individual and family-related traits at the 10% to 1% significance level. Our parameter estimates for marginal effects indicate that women have an approximately 9.83 percentage point higher risk of LBP than their male counterparts ($p<0.01$). Additionally, LBP risk tends to increase gradually with age, with individuals over 64 having twice the risk compared to those aged 30-44. Compared to the reference group, the 30-44 age group had an approximately 8.86% increased risk of chronic LBP ($p<0.01$), while the 45-64 age group had a 13.64% increased risk ($p<0.01$), and those over 65 had a 16.96% increased risk ($p<0.01$).

TABLE 2: Parameters and marginal effects from the random-effects probit model.

	Random-effects probit model			Marginal effects		
Variable	**Estimates %**	**p-value**	**95% CI**	**Estimates %**	**p-value**	**95% CI**
Constant	-0.511[a]	0.000	(-0.726, -0.295)	–	–	–
Individual traits:						
Gender	-0.316[a]	0.000	(-0.381, -0.251)	-9.833[a]	0.000	(-11.869, -7.797)
Age classification:						
Age 30-44 years	0.285[a]	0.000	(0.198, 0.372)	8.856[a]	0.000	(6.134, 11.577)
Age 45-64 years	0.439[a]	0.000	(0.338, 0.539)	13.642[a]	0.000	(10.502, 16.783)
Age >64 years	0.545[a]	0.000	(0.417, 0.674)	16.958[a]	0.000	(12.941, 20.974)
Marital status:						
Unmarried	-0.312[a]	0.000	(-0.435, -0.188)	-9.690[a]	0.000	(-13.535, -5.845)
Married	-0.034	0.465	(-0.125, 0.057)	-1.052	0.465	(-3.875, 1.771)
Education levels:						
Elementary school	-0.150[a]	0.000	(-0.229, -0.072)	-4.676[a]	0.000	(-7.126, -2.225)
Secondary school	-0.258[a]	0.000	(-0.359, -0.158)	-8.035[a]	0.000	(-11.167, -4.902)
High school	-0.265[a]	0.000	(-0.364, -0.167)	-8.245[a]	0.000	(-11.311, -5.179)
College	-0.333[a]	0.000	(-0.440, -0.226)	-10.355[a]	0.000	(-13.705, -7.005)
Employment types:						
Working	-0.008	0.829	(0.080, 0.064)	-0.248	0.829	(-2.495, 1.999)
Job seeking	-0.145[a]	0.007	(-0.251, -0.039)	-4.510[a]	0.007	(-7.792, -1.227)
Retired	-0.102[b]	0.023	(-0.190, -0.014)	-3.166[b]	0.023	(-5.898, -0.434)
Body mass index classification:						
Overweight	0.174[a]	0.000	(0.119, 0.229)	5.411[a]	0.000	(3.701, 7.120)
Obese	0.282[a]	0.000	(0.212, 0.352)	8.757[a]	0.000	(6.564, 10.950)
Over obese	0.333[a]	0.000	(0.231, 0.435)	10.350[a]	0.000	(7.155, 13.544)
Health insurance types:						
Social security coverage	-0.010	0.833	(-0.100, 0.081)	-0.303	0.833	(-3.110, 2.504)
Private health insurance	-0.117[c]	0.091	(-0.251, 0.018)	-3.620[c]	0.091	(-7.815, 0.574)
Different sports activities:						
Walking time	-0.059[c]	0.078	(-0.125, 0.007)	-1.835[c]	0.078	(-3.874, 0.204)
Sports	-0.022	0.662	(-0.119, 0.076)	-0.676	0.662	(-3.705, 2.352)
Resting	0.053[b]	0.040	(0.002, 0.104)	1.656[b]	0.040	(0.074, 3.238)
Job classification:						
Moderate job	-0.051[c]	0.059	(-0.105, 0.002)	-1.596[c]	0.059	(-3.250, 0.058)
Heavy physical work	0.155[b]	0.014	(0.032, 0.279)	4.825[b]	0.014	(0.984, 8.666)
Tobacco and alcohol behavior:						
Tobacco	0.057[b]	0.036	(0.004, 0.110)	1.762[b]	0.036	(0.119, 3.405)
Alcohol	0.062	0.233	(-0.040, 0.162)	1.905	0.234	(-1.229, 5.039)
Fruit consumption	-0.163[a]	0.000	(-0.247, -0.080)	-5.080[a]	0.000	(-7.679, -2.481)
Vegetable consumption	-0.047	0.467	(-0.175, 0.080)	-1.470	0.467	(-5.430, 2.491)
Fruit juice	-0.025	0.388	(-0.083, 0.032)	-0.788	0.388	(-2.577, 1.002)
Soft drink	-0.066[b]	0.016	(-0.119, -0.012)	-2.042[b]	0.016	(-3.702, -0.381)
Depression	0.538[a]	0.000	(0.463, 0.612)	16.714[a]	0.000	(14.367, 19.060)
Hypertension	0.293[a]	0.000	(0.228, 0.356)	9.081[a]	0.000	(7.075, 11.086)
Family traits:						
Numbers of kids	-0.064[a]	0.004	(-0.108, -0.021)	-2.001[a]	0.004	(-3.350, -0.651)
Income groups:						
Income 3,398-6,890 TL	0.010	0.733	(-0.049, 0.069)	0.316	0.733	(-1.504, 2.137)
Income >6,890 TL	-0.086[b]	0.043	(-0.170, -0.003)	-2.683[b]	0.043	(-5.280, -0.086)
Family types:						
Spouses only	0.002	0.977	(-0.101, 0.104)	0.048	0.977	(-3.130, 3.225)
Spouses with kids	-0.017	0.645	(-0.088, 0.054)	-0.519	0.645	(-2.727, 1.690)

TABLE 2: Parameters and marginal effects from the random-effects probit model *(contunied)*.

	Random-effects probit model			Marginal effects		
Variable	**Estimates %**	**p-value**	**95% CI**	**Estimates %**	**p-value**	**95% CI**
Regions:						
İstanbul	0.183[a]	0.002	(0.068, 0.299)	5.710[a]	0.002	(2.109, 9.311)
Western Marmara	0.043	0.494	(-0.080, 0.166)	1.332	0.494	(-2.487, 5.152)
Eastern Marmara	-0.045[a]	0.546	(-0.192, 0.102)	-1.409	0.546	(-5.982, 3.165)
Aegean	0.228[a]	0.001	(0.088, 0.368)	7.079[a]	0.001	(2.726, 11.433)
Mediterranean	0.057	0.361	(-0.065, 0.180)	1.777	0.361	(-2.033, 5.588)
Western Anatolia	0.158	0.102	(-0.032, 0.347)	0.049	0.103	(-0.981, 10.781)
Central Anatolia	0.070	0.230	(-0.045, 0.185)	2.186	0.230	(-1.385, 5.756)
Western Black Sea	0.012	0.862	(-0.125, 0.149)	0.378	0.862	(-3.880, 4.635)
Eastern Black Sea	0.167[a]	0.003	(0.056, 0.277)	5.177[a]	0.003	(1.754, 8.601)
Southeastern Anatolia	0.121	0.128	(-0.035, 0.277)	3.769	0.128	(-1.079, 8.618)
Rho (ρ)	0.192[a]	0.000	(0.210, 0.283)			
Log-likelihood value	-9397.946					
LR test when ρ=0	118.22[a] (df=1, p-value<0.000)					
LR test when all parameters except constant term equal zero	2470.98[a] (df=46, p-value<0.000)					

a, b, and c show statistical significance at the 1%, 5%, and 10% levels, respectively, while CI stands for the confidence interval and df stands for degrees of freedom. Table 2 comprises six columns, with the initial three columns presenting coefficient statistics pertaining to the random-effects probit model. These coefficients have been determined through the maximization of the log-maximum likelihood function (Equation 14). Conversely, the subsequent three columns delineate the influence of each risk factor on the prevalence of low back pain; df: Degrees of freedom; CI: Confidence interval; LR: Likelihood ratio.

Marital status also played a role, with never-married and married individuals experiencing 9.69% and 1.05% lower LBP prevalence, respectively, compared to widowed or divorced individuals. However, such a difference was statistically significant only for never-married individuals ($p<0.01$). Education demonstrated an inverse relationship with LBP prevalence ($p<0.01$ for all categories). University graduates had a 10.36% lower likelihood of experiencing LBP compared to those without a diploma ($p<0.01$). Regarding employment, employees, job seekers, and retired individuals had a 0.25%, 4.50%, and 3.17% lower risk of LBP, respectively, compared to the reference group. Individuals with private health insurance had a 3.62 percentage point lower prevalence of LBP ($p<0.01$), while the presence of children under 6 years at home was associated with a 2% lower LBP risk ($p<0.000$).

Obesity was positively correlated with LBP, with an even higher risk for morbidly obese individuals. Smoking increased LBP risk by 1.76% ($p<0.01$), and depression and hypertension were directly related to LBP, with depression having a more pronounced effect. Individuals who walked for over an hour a day had a 1.84% lower LBP risk ($p<0.05$), while physically demanding jobs increased LBP risk by 4.83 points. Resting less than four hours a day also raised the likelihood of LBP ($p<0.01$). Conversely, consuming more than one portion of fruits and vegetables daily was associated with a lower LBP risk ($p<0.01$), and carbonated drink consumption had an inverse relationship with LBP ($p<0.01$). Finally, the geographic region had an impact on LBP prevalence, with the eastern Marmara region being an exception to the general trend. İstanbul, Aegean, and Eastern Black Sea regions displayed statistically significant differences in LBP prevalence. İstanbul and Aegean, known as heavy industrial centers, and the Eastern Black Sea region, known for agriculture, had distinct LBP prevalence rates.

DISCUSSION

In the following discussion, we have gathered some traits that share some similarities for convenience and presented their corresponding results below. Our findings on gender differentiation generally coincide with the findings of some studies in Türkiye however, they contradict the results of other national stud-

ies.[10,17,25,26] Such a result is also consistent with international findings, reporting that biopsychosocial risk factors such as fluctuations in the menstrual cycle, biological response to pregnancy and childbearing, perimenopausal abdominal weight gain, the physical stress of parenting, housework, and errands contribute to a higher overall prevalence of LBP in women.[3,6,18,27] In this context, the monitoring process of working women against possible LBP risk should be expanded by employers, and they should be assigned to less risky positions where necessary.

The effects of age reported in the current study are in line with the findings reported in previous studies.[6] The initial attack of LBP in the body typically occurs between the ages of 30 and 50. In later years, bone strength and functionality are lost due to osteoporosis and can fracture, while muscles lose elasticity and tone gradually as well as functionality. On the other hand, with aging, intervertebral discs lose their fluid and flexibility features, reducing their ability to cushion the vertebrae and increasing the risk of spinal stenosis.[28] The effects of cumulative deterioration of the body in the last ring of the life cycle can be avoided to the extent that a healthier diet and avoidance of heavy physical work are accepted as a way of life, especially during adolescence and adulthood. Additionally, the age effects reported in the current study are in line with the findings reported in previous studies.[4,6,11] Meanwhile, when considering marital status, it was reported that widowed or separated individuals were exposed to a higher risk of LBP than their single or married peers.[29] However, those who were divorced, married, separated, and widowed were at least 1.5 times more likely to experience LBP than older adults who had never been married.[23] The active social and working lives and economic distress of widowed or divorced individuals with household errands can be associated with an increased risk of depression and anxiety, which, in turn, can lead to musculoskeletal disorders such as LBP. Our findings are consistent with previous findings.[6,11]

Our results also show that the prognosis of LBP is more favorable due to the fund of knowledge (i.e., education). Such results indicate that the accumulated knowledge gained through education during school periods leads to a healthier life for an individual in the following years. Such a relationship can be partly attributed to the fact that people tend to adopt a healthier lifestyle (diet and exercise habits) as they progress in education. Mechanisms that may explain these statistical associations include differences in behavioral and environmental perceptions or responses by educational levels, differences in occupational factors, low "health stock" among highly educated people, differences in health care access and use, and stress management.[17,30] Our findings are also consistent with previous findings.[6,11,16] The risk of exposure to LBP can be reduced to prevent possible risks that may arise from the work environment, and/or the importance of occupational safety is gradually reflected in the education curriculum.

People with disabilities, housewives, maids, and those who perform their compulsory military service in Türkiye are more likely to experience LBP due to the risk of encountering a more difficult work life. Among the apparent risk factors for LBP for such individuals are strange and prolonged static posture, repetitive body trunk overrotation/flexion, manual material use, strong exertion, and vibration, as well as factors such as stress and working environment (i.e., psychosocial stress, working time, job satisfaction, and working intensity).[6,10,11,16,31] Prolonged, slumped sitting at work disrupts spinal stability, causing internal oblique and transversus abdominis muscle fatigue in the lumbar region.[10] Working environments, including the length of breaks and their frequency, can be redesigned in workplaces to mitigate such effects so that work productivity is not hindered.

Individuals covered by health insurance tend to benefit from more health services, as they have higher incomes and education. Bones, muscles, and other structures in the spine need proper nutrition to support the body and perform other functions. Highly educated and high-income people are more likely to maintain their overall health, including back pain, by including back-friendly foods in their daily diet. On the other hand, interestingly, exposure to LBP in adults decreases with the increase in the number of children under the age of six in the family in Türkiye. Adult exposure to LBP is reduced, possibly because adult family members have to care for children more at home and outside. A greater positive effect on

women is expected. Meanwhile, high-income individuals in the country are much less likely to experience LBP than low-income individuals. Such a result is expected because access to health services is likely to increase with income. Our results concerning the income variable are in line with previous findings.[11] Comorbidity diseases are likely to become widespread in low-income families, as they do not have a well-balanced diet and do not receive any services from health institutions.

The results show that extremely obese individuals are approximately two times more likely to experience LBP risk than overweight individuals in Türkiye. Our results are consistent with the findings in the literature, suggesting that excess weight can strain the spine, disrupt spinal stability, and lead to unnatural curvature, resulting in back pain.[5,6,8,10,16,32,33] Additionally, adipose tissue, as an endocrine organ, contributes to inflammation and other mechanisms associated with obesity-related chronic low-grade inflammation.[34] To address this issue, education systems should incorporate information about obesity and its health effects, and employers can organize health seminars to raise awareness among employees. The government could also consider imposing additional taxes on high-calorie, unhealthy foods to discourage consumption, as is widely practiced by nations around the world. While some studies have not found a direct relationship between smoking and LBP, negative effects of smoking on functional status indirectly affect LBP risk. Smoking can lead to increased coughing, which exacerbates lumbar disc degeneration. Additionally, smoking has been linked to osteoporosis, prevention of spinal fusions, and impaired fracture healing.[9,16,35] Smoking also hampers oxygen transfer, causes vasoconstriction, and contributes to malnutrition of intervertebral discs, which can lead to increased pain. Smoking cessation programs and public health initiatives can help address these concerns.

Depression and hypertension are directly related to LBP exposure, with depression having a more significant impact. Psychological issues, particularly depression, can be a persistent risk factor for LBP. Individuals with weak social ties may be more vulnerable to LBP due to depression and other comorbidities, necessitating targeted public health programs and resource allocation.[36] Considering numerous studies investigating the relationship between LBP and walking, it can be summarized that exercise has either a neutral or beneficial effect on LBP risk.[37] Our study suggests an inverse relationship between LBP and walking for more than an hour a day, indicating that increased physical activity may reduce LBP prevalence. A similar finding reported that longer sitting and low physical activity increased the prevalence of LBP among Koreans.[38] Further studies are needed to investigate the effects of different exercise programs on LBP, detailing exercise type and duration.

Back pain during or after heavy lifting, especially in the construction, agriculture, and transportation industries, is caused by poor posture or poor lifting technique, where the rounding of the back is a common problem that can put your hips at an awkward angle, putting pressure on the ligaments around the spine. While many systematic reviews have shown that weight lifting affects the formation of LBP, others have contradicted these results, finding contradictory or even no evidence for the finding that lifting is a causal factor for the occurrence of LBP.[39,40] On the other hand, workaholism is significantly associated with poor psychological health, back pain, and other disease burdens, especially mental health problems. Therefore, workaholics should be filtered when considering the welfare of workers. In contrast, consuming carbonated drinks triggers electrical impulses that might cause a small amount of pain in the body, while an anti-inflammatory-rich diet of fruits, vegetables, lean proteins such as fish and chicken, and healthy fats such as nuts and olive oil may alleviate and help suppress inflammation in the body that can worsen chronic pain, including the lower back. Finally, regarding the significant difference between regions in Türkiye, the replacement of physical work with robotic work in heavy industrial areas and the substitution of machine transport instead of back basket transport may be factors that relatively mitigate the rate of LBP disease.

CONCLUSION

In the realm of international ergonomics research, including studies conducted in Türkiye, the exploration

of the connection between LBP and its associated risk factors has predominantly centered around specific occupational groups. However, there has been a notable scarcity of population-based cross-sectional studies and investigations utilizing multilevel datasets. In this study, we address such a gap by employing cross-sectional population-based multilevel datasets and a random-effects probit model to statistically determine the magnitude and direction of risk factors associated with LBP incidence in Türkiye.

Statistical tests confirm the effectiveness of the random-effects probit model in capturing family-level variations and its suitability for data analysis. Most risk factors identified in our research significantly correlate with LBP prevalence, aligning with existing literature. Given that about a quarter of the population is under 30 and almost half are employed, including those in pertinent healthcare sectors, projecting how individual and family-level risk factors intersect with LBP prevalence becomes crucial. Such projections can inform the development of more robust workplace programs aimed at enhancing productivity.

Moreover, considering LBP's multifaceted nature and susceptibility to age-related changes, healthcare providers should prioritize innovative imaging techniques for precise diagnosis. Such technologies can offer valuable insights into the root causes of pain and expedite clinical decisions. Advances in biomarker identification and a better understanding of the aging population hold the potential to create personalized therapeutic approaches in LBP management. In conclusion, the current study sheds light on the multifaceted factors influencing LBP prevalence, ranging from demographics and lifestyle choices to geographic location. Such findings provide valuable insights into the epidemiology of LBP and may inform public health interventions and targeted treatments for affected individuals. Further research and exploration are warranted to better understand the complex interplay of such factors.

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