ORİJİNAL MAKALE / ORIGINAL ARTICLE

Balıkesir Sağlık Bilimleri Dergisi / BAUN Sağ Bil Derg
Balıkesir Health Sciences Journal / BAUN Health Sci J
ISSN: 2146-9601- e ISSN: 2147-2238
Doi: https://doi.org/10.53424/balikesirsbd.1116258

Evaluation of the Relationship Between Air Temperature and Treatment Cost in Diabetic Foot Infections

Burcu BEYAZGÜL[1], Çiğdem CİNDOĞLU[2]

[1] Harran University, Medical Faculty, Department of Public Health
[2] Harran University, Medical Faculty, Department of Internal Medicine

Geliş Tarihi / Received: *13.05.2022,* ***Kabul Tarihi / Accepted:*** *04.01.2023*

ABSTRACT

Objective: When diabetic patients have problems in foot care, diabetic foot wounds can occur, and untreated diabetic foot infections can cause amputation and death. In this study, it is aimed to evaluate the air temperature and treatment costs in diabetic foot patients treated in a University Hospital. **Materials and Methods:** The study is of ecological type. The population of the study consisted of 123 diabetic foot patients who were treated in a hospital in 2019. Demographic characteristics of the patients such as age, gender, duration of diabetes, Wagner classification, length of hospital stay, cost of treatment, and climate parameters were examined. **Results:** The mean hospital stay of the patients was 13.81±9.22 (min:1 max:43) days. The mean hospitalization cost of the patients was 2724.95±2344.04 (min:228 max:15,208) Turkish Lira (TL). The cost of treatment was higher in patients who were elderly, had a long hospital stay, and had a Wagner classification of 3 and above ($p<0.05$). It was found that the decrease in air temperature increased the cost of treatment ($p<0.05$). **Conclusion:** It is thought that the decrease in air temperature complicates the treatment of infection and increases the cost of treatment. When planning the treatment of infection, vasoconstriction and inflammation should be taken into account on days when the air temperature decreases.

Keywords: Diabetic Foot, Treatment Cost, Air Temperature.

Diyabetik Ayak Enfeksiyonlarında Hava Sıcaklığı ve Tedavi Maliyeti İlişkisinin Değerlendirilmesi

ÖZ

Amaç: Diyabet hastalarında ayak bakımı konusunda sorunlar yaşandığında, diyabetik ayak yaraları oluşabilmekte, tedavi edilmeyen diyabetik ayak enfeksiyonları da amputasyon ve ölüme sebep olabilmektedir. Bu çalışmada bir Üniversite Hastanesi'nde yatarak tedavi edilen diyabetik ayak hastalarında hava sıcaklığı ile tedavi maliyetlerinin değerlendirilmesi amaçlanmaktadır. **Gereç ve Yöntem:** Çalışma ekolojik tiptedir. Çalışmanın evrenini 2019 yılında bir hastanede yatarak tedavi edilen 123 diyabetik ayak hastası oluşturdu. Hastaların yaş, cinsiyet, diyabet süresi gibi demografik özellikleri, Wagner sınıflaması, hastanede yatış süresi, tedavi maliyeti, iklim parametreleri incelendi. **Bulgular:** Hastaların ortalama hastanede yatış süreleri 13.81±9.22 (min=1, max=43) gündü. Hastaların hastanede yatış maliyeti ortalamaları 2724.95±2344.04 (min=228 max=15.208) Türk Lirası (TL) idi. Yaşlı, yatış süresi uzun ve Wagner sınıflaması 3 ve üzerinde olan hastalarda tedavi maliyeti daha yüksekti ($p<0.05$). Hava sıcaklığının azalmasının tedavi maliyetini artırdığı bulundu ($p<0.05$). **Sonuç:** Hava sıcaklığı azalmasının enfeksiyon tedaviyi güçleştirdiği ve tedavi maliyetini artırdığı düşünülmektedir. Enfeksiyon tedavisi planlanırken, hava sıcaklığının azaldığı günlerde vazokonstruksiyon ve inflamasyonun dikkate alınması gerekmektedir.

Anahtar Kelimeler: Diyabetik Ayak, Tedavi Maliyeti, Hava Sıcaklığı.

Sorumlu Yazar / Corresponding Author: Burcu BEYAZGÜL, Harran University, Medical Faculty, Department of Public Health Şanlıurfa, Turkey.
E-mail: brckara86@hotmail.com

Bu makaleye atıf yapmak için / Cite this article: Beyazgul, B., & Cindoglu, C. (2023). Evaluation of the relationship between air temperature and treatment cost in diabetic foot infections. *Health Sci J, 12(1): 8-13.* https://doi.org/10.53424/balikesirsbd.1116258

INTRODUCTION

According to the data of the World Health Organization, approximately 422 million people worldwide have diabetes. Annually, 1.5 million deaths are directly linked to diabetes and its complications (WHO, 2022). Although there are many different subtypes of diabetes, type 1 and type 2 diabetes are the most common. In type 1 diabetes, there is an insulin secretion disorder that is predominantly of immune origin, while type 2 diabetes is a picture that appears with a decrease in insulin effect and resistance (Harreiter & Roden, 2019). Microvascular and macrovascular complications may occur during the course of diabetes. Microvascular complications of diabetes are diabetic kidney disease, diabetic retinopathy, diabetic neuropathy. Macrovascular complications are; cardiovascular disease, cerebrovascular disease and peripheral artery disease (Eroğlu, 2018). Diabetic foot ulcer (DFU) is a common complication of diabetes that occurs due to both microvascular and macrovascular causes. It is a condition presenting with poor glycemic control, neuropathy, dry skin, as well as skin abrasion and ulceration caused by trauma. DFU is a complication that increases mortality and morbidity, can lead to amputation, and impairs quality of life (Abdissa et al., 2020; Khateeb et al., 2019; Reardon et al, 2020; Staiger et al., 2015). Those with DFU are at a 2.5-fold increased risk of death compared with other non-DFU diabetics (Walsh et al., 2016).

It is estimated that the lifetime frequency of developing DFU in diabetic patients is within the range of 19%–34% and that 9.1–26.1 million people are at risk of DFU annually (Beyaz et al., 2017; Everett & Mathioudakis, 2018).

DFU is one of the important causes for hospitalization among diabetic patients. Infection treatment, wound care, and amputation, which are necessary in DFU care, have high treatment costs. There are many studies examining factors, such as Wagner classification, platelet-to-lymphocyte ratio (PLO), duration of hospitalization, and amputation, to estimate inpatient treatment costs among patients with DFU (Eren et al., 2020; Callahan et al, 2016; Kim et al, 2016; Ignatyeva et al., 2015; Hicks et al, 2016). Air temperature is also reported to affect the treatment of DFU (Lam et al., 2018; Petrofsky, 2011).

Morbidity and mortality rates may change with air temperature in diabetic patients. It is known that both extremely low air temperature and extremely high air temperature can increase life years lost due to diabetes (Bai et al, 2016; Li et al, 2017; Luan et al., 2018; Preston et al., 2020; Seposo et al., 2017; Vallianou et al, 2021). Thermoregulation may be impaired due to endothelial dysfunction and poor cutaneous blood flow in these patients, which may increase the risk of cardiac stress and cardiovascular disease through inflammatory, vasoconstriction, and thrombosis mechanisms (Cai et al, 2016; Lam et al., 2018; Petrofsky, 2011). DFU treatment is difficult, as blood flow is poor and antibiotics may have difficulty in reaching the target tissue (Abdissa et al., 2020).

Although there are many studies showing that the prognosis of both diabetes and DFU may change with air temperature, these studies mostly focused on the clinical findings of the patients and the life span of the patients. The effect of air temperature on treatment costs in diabetes and DFU has not been investigated. This study aimed to evaluate some socio-demographic and clinical characteristics and the effect of air temperature on treatment costs of diabetic foot patients receiving inpatient treatment in a hospital.

MATERIALS AND METHODS

Type of research

The study is a descriptive study of ecological type.

Place and time of research

This study consisted of 128 diabetic foot patients hospitalized in 2019.

The study population and sample of the research

Those with findings of systemic infection, purulent wounds, or at least two local infections were included as 'diabetic foot patients'. The study did not include a specific sample; all inpatients treated at the University Hospital in 2019 were included in the study. Patients with infections other than those of diabetic foot (five patients) were excluded from the study, and those with Wagner grade one were excluded from the study because they were treated as outpatients (two patients). A total of 121 patients were finally included, and the hospital's patient records from 2019 were used for the study.

Variables

The dependent variable of the study was the treatment cost. Treatment expenses, such as physical examination of the patients, laboratory tests for diagnosis, blood glucose regulation, wound care, antibiotic administration and inpatient stay, were taken as "treatment cost" (Eren et al., 2020).

The independent variables of the study were age, gender, duration and type of diabetes, Wagner classification, duration of hospitalization and climatic characteristics such as air temperature, humidity, dew content, and air pressure during the first days of hospitalization (Weather Underground, 2020). The Wagner classification is based on the depth of the lesion. Although there is no wound, it has a spectrum ranging from a risky foot to a gangrenous foot (Bozkurt et al., 2011).

Data collection

Data were collected using hospital records (from January 1, 2019 to December 31, 2019).

Statistical analysis

The SPSS 20 program was used for the data analysis herein. Percentage, mean, and standard deviation were used as descriptive statistics in data analysis. Univariate analyses were performed using t-test and one-way analysis of variance as the data was normally distributed. Climate characteristics, age and duration of diabetes and hospitalization were

categorized using the median cut off value. Linear regression analysis was performed to control the effects of independent variables. In the regression model, gender variable was considered as dichotomous, Wagner classification as sequential data, and other variables (age, duration of hospitalization, and air temperature) as continuous data.

Ethical considerations

This study has received permission from the Harran University Faculty of Medicine Clinical Research Ethics Committee with the 13.07.2020 date, 13. Session and Decision No. 09. Institutional permission was obtained from the hospital where the study was conducted in order to access the patient records used in the study.

RESULTS

38.0% of the patients were female, 95.9% had type two diabetes mellitus, and the rest had type one diabetes mellitus. Their mean age was 59.14±10.88 (min: 25 max: 87), and the mean duration of diabetes was 14.34±7.72. As per Wagner's diabetic foot classification, 24.0% of the patients were grade two, 33.90% grade three, 21.50% grade four, and 20.70% grade five. The mean duration of hospitalization in one year was 13.81±9.22 (min= 1 max=43) days. The mean hospitalization cost of the patients was 2724.95±2344.04 (min: 228 max: 15.208) Turkish lira. When the relationship between the treatment cost of the patients and some demographic variables was examined, male, elderly patients, with long duration of hospitalization, who having Wagner grade three or higher had higher treatment costs (respectively p=0.03, p=0.02, p=0.00 and p=0.00). The relationship between diabetes duration and treatment cost was not significant (p=0.40) (Table 1).

Inpatient treatment costs and air temperature were statistically significant (p=0.03). When the air temperature was 21.5 degrees and below, the cost of treatment was increasing. The effect of humidity, dew point and pressure on treatment cost was not statistically significant (respectively p=0.87, p=0.55 and p=0.31) (Table 2).

In the linear regression analysis performed to show the combined effect of independent variables on the cost of inpatient treatment of DFU; decrease in air temperature increased the cost 36.85 times, age 31.96 times, hospitalization time 107.79 times, and Wagner classification 425.11 times (respectively p=0.03, p=0.05, p=0.00 and p=0.00) (Table 3).

Table 1. Relationship between some characteristics of the patients and the treatment cost (n=121).

Variables		Cost of stay (Turkish lira)		Analysis	
		Mean	SD	t	p
Age	59 years and below	2255.11	1491.83	**2.26**	**0.02**
	60 years and above	3218,67	2922.90		
Gender	Female	2161.45	1530.55	**2.10**	**0.03**
	Male	3070.56	2677.14		
Duration of diabetes	15 years and below	2572.70	2113.78	0.83	0.40
	16 years and above	2933.92	2635.14		
Length of stay	12 days and less	1874.88	2009.05	**4.30**	**0.00**
	13 days and above	3589.18	2358.80		
Wagner classification	grade 2*	1616.06	1149.40	**5.56 ***	**0.00**
	grade 3	2384.36	1150.00		
	grade 4	3570.61	2733.26		
	grade 5	3690.32	3537.75		

*Significant difference **Analyzed using one-way analysis of variance.

Table 2. Relationship between treatment cost of patients and climate parameters (n=121).

Variables		Cost of stay (Turkish lira)		Analysis	
		Mean	SD	t	P
Temperature	21.5 and below	3169.63	2453.69	**2.13**	**0.03**
	21.6 and above	2272.85	2154.15		
Humidity	37.7 and below	2689.83	2570.00	0.16	0.87
	37.8 and above	2759.49	2119.38		
Dew point	28.1 and below	2279.33	927.83	0.59	0.55
	28.2 and above	2760.75	2420.87		
Pressure	28.1 and below	2516.19	2110.84	1.00	0.31
	28.2 and above	2944.32	2566.39		

Table 3. Linear regression model evaluating the combined effect of independent variables on treatment cost in DFU (n=121).

Variables	B	t	p	95% Confidence interval	
				Lower bound	Upper bound
Age	**31.96**	1.92	**0.05**	-0.89	714.82
Gender (Male)	492.49	1.32	0.18	-243.95	1228.93
Length of stay	**107.79**	5.49	**0.00**	68.95	146.64
Wagner classification	**425.11**	2.72	**0.00**	115.70	734.51
Temperature	**-36.85**	-2.15	**0.03**	-70.68	-3.02
Analysis of variance F=12.63 p=0.00					
Durbin–Watson= 1.84					

DISCUSSION

DFU is a disease that occurs secondary to the microvascular and macrovascular complications of diabetes. Many studies report that the risk of DFU increases with older age and diabetes duration (Jalilian et al 2020; Jiang et al, 2015; Niakan et al, 2020; Ponirakis et al, 2020; Zukic et al., 2015). In this study, we found that treatment costs increased with older age, which was consistent with previous studies. With age, a straining effect occurs on vascular structures, and therefore, the risk of DFU is expected to increase with older age. As the length of hospital stay increases, treatment costs increase in DFU (Eren et al., 2020). In this study, it was found that the increase in the length of stay increased the treatment costs. With older age, it becomes difficult to control diabetes and its complications, and treatment becomes difficult (Jalilian et al., 2020; Niakan et al, 2020; Ponirakis et al, 2020). This may prolong the duration of hospitalization and increase the cost of treatment.

Many studies investigating the severity of DFU and amputation risk factors have found that Wagner classification can affect the disease progress (Eren et al., 2020; Jalilian et al., 2020; Jiang et al, 2015; Kim et al, 2018; Niakan et al, 2020; Zukic et al., 2015). Eren et al. stated that as the grade (i.e. ulcer severity) of Wagner classification and duration of hospitalization increased in DFU, the cost of treatment increased (Eren et al., 2020). The current study also determined that the length of hospitalization and Wagner classification increased the cost. The Wagner classification is a classification system based on the depth of the lesion, and includes grades ranging from high-risk cases of non-ulcerated foot to severe cases of extensive gangrene involving the whole foot. As it is a marker indicating the course of the disease, it can be said that the increase in the Wagner grade will change the treatment procedures and cost.

There are studies showing that exposure to cold can cause cardiovascular risks in susceptible patients, increase hospitalization duration, and trigger death. Cold-related effects may be more severe in type two diabetes patients who already have an impaired physiological response mechanism (Cai et al, 2016; Phung et al., 2016).

In this study, air temperature and treatment cost were found to be inversely correlated. It was found that as the air temperature decreased, the cost of treatment increased. A study by Cai et al. revealed that every one degree celsius decrease in daily mean air temperature led to an increase of 2.2%–15.1% in the biomarkers of inflammation, 1.4%–24.5% in coagulation, and 8.2% in vasoconstriction (Cai et al, 2016). We believe that the increase in inflammation and vasoconstriction experienced in cold weather, together with unstable thermoregulation mechanisms in diabetic patients, worsens the diabetic foot symptoms, delays the treatment response, prolongs the treatment process, increases the duration of hospitalization, and therefore, increases the cost of treatment (Lam et al., 2018; Petrofsky, 2011).

CONCLUSION

As the age, hospitalization duration, and the Wagner grade increases, the treatment cost of the patients increases. One must pay special attention to DFU care in patients in the geriatric age group with prolonged hospitalization duration.

As the air temperature decreases, the cost of treatment increases. In order to prevent DFU formation, diabetic patients should be given health education along with information regarding paying special attention to foot care on days when the air temperature is low.

Limitations of study

The study is the first to examine the relationship between climate characteristics and the cost of diabetic foot treatment. For this reason, it is thought that it will contribute to the literature. The limitation of the study is that it was conducted only in a single hospital and that it did not represent other hospitals.

Acknowledgement

The authors would like to extend their sincere thanks to anyone who contributed to this study.

Conflict of Interest

The author declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Author Contributions

Plan, design: BB, CC; **Material, methods and data collection:** BB, CC; **Data analysis and comments:** BB, CC; **Writing and corrections:** BB, CC.

REFERENCES

Abdissa, D., Adugna, T., Gerema, U., & Dereje, D. (2020). Prevalence of diabetic foot ulcer and associated factors among adult diabetic patients on follow-up clinic at Jimma Medical Center, Southwest Ethiopia, 2019: an institutional-based cross-sectional study. *Journal of diabetes research*, 2020. https://doi.org/10.1155/2020/4106383

Bai, L., Li, Q., Wang, J., Lavigne, E., Gasparrini, A., Copes, R., et al. (2016). Hospitalizations from hypertensive diseases, diabetes, and arrhythmia in relation to low and high temperatures: population-based study. *Scientific Reports*, *6*(1), 1-9. doi: 10.1038/srep30283.

Beyaz, S., Güler, Ü. Ö., & Bağır, G. Ş. (2017). Factors affecting lifespan following below-knee amputation in diabetic patients. *Acta Orthopaedica et Traumatologica Turcica*, *51*(5), 393-397. https://doi.org/10.1016/j.aott.2017.07.001.

Bozkurt, F., Tekin, R., Çelen, M. K., & Celal, A. Y. A. Z. (2011). Diyabetik ayak enfeksiyonlu hastalarda Wagner sınıflaması ve kültür sonuçlarının değerlendirilmesi. *Dicle Tıp Dergisi*, *38*(1).

Cai, J., Meng, X., Wang, C., Chen, R., Zhou, J., Xu, X., et al. (2016). The cold effects on circulatory inflammation, thrombosis and vasoconstriction in type 2 diabetic patients. *Science of The Total Environment*, 568, 271-277. https://doi.org/10.1016/j.scitotenv.2016.06.030.

Callahan, D., Keeley, J., Alipour, H., DeVirgilio, C., Kaji, A., Plurad, D., et al. (2016). Predictors of severity in diabetic foot infections. *Annals of Vascular Surgery*, 33, 103-108. https://doi.org/10.1016/j.avsg.2016.01.003.

Eren, M. A., Güneş, A. E., Kırhan, İ., & Sabuncu, T. (2020). The role of the platelet-to-lymphocyte ratio and neutrophil-to-lymphocyte ratio in the prediction of length and cost of hospital stay in patients with infected diabetic foot ulcers: A retrospective comparative study. *Acta Orthopaedica et Traumatologica Turcica*, *54*(2), 127. https://doi.org/10.5152/j.aott.2020.02.518.

Eroğlu, N. (2018). Dıabetes mellıtus'un komplikasyonları. *Izmir Democracy University Health Sciences Journal*, *1*(2), 6-12.

Everett, E., & Mathioudakis, N. (2018). Update on management of diabetic foot ulcers. *Annals of the New York Academy of Sciences*, *1411*(1), 153-165. https://doi.org/10.1111/nyas.13569.

Harreiter J, Roden M. (2019). Diabetes mellitus-Definition, classification, diagnosis, screening and prevention. *Wien Klin Wochenschr*. 2019; *131*(Suppl 1):6-15. https://doi.org/10.1007/s00508-019-1450-4.

Hicks, C. W., Selvarajah, S., Mathioudakis, N., Sherman, R. L., Hines, K. F., Black III, et al. (2016). Burden of infected diabetic foot ulcers on hospital admissions and costs. *Annals of Vascular Surgery*, *33*, 149-158. https://doi.org/10.1016/j.avsg.2015.11.025.

Ignatyeva, V. I., Severens, J. L., Ramos, I. C., Galstyan, G. R., & Avxentyeva, M. V. (2015). Costs of hospital stay in specialized diabetic foot department in Russia. *Value in Health Regional Issues*, 7, 80-86. https://doi.org/10.1016/j.vhri.2015.09.003.

Jalilian, M., Sarbarzeh, P. A., & Oubari, S. (2020). Factors related to severity of diabetic foot ulcer: a systematic review. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 13, 1835. doi: 10.2147/DMSO.S256243.

Jiang, Y., Wang, X., Xia, L., Fu, X., Xu, Z., Ran, X., et al. (2015). A cohort study of diabetic patients and diabetic foot ulceration patients in China. *Wound Repair and Regeneration*, *23*(2), 222-230. https://doi.org/10.1111/wrr.12263.

Khateeb, J., Fuchs, E., & Khamaisi, M. (2019). Diabetes and lung disease: an underestimated relationship. *Review of Diabetic Studies*, *15*(1), 1-15. https://doi.org/10.1900/RDS.2019.15.1.

Kim, T. G., Moon, S. Y., Park, M. S., Kwon, S. S., Jung, K. J., Lee, T., et al. (2016). Factors affecting length of hospital stay and mortality in infected diabetic foot ulcers undergoing surgical drainage without major amputation. *Journal of Korean Medical Science*, *31*(1), 120-124. https://doi.org/10.3346/jkms.2016.31.1.120.

Kim, S. Y., Kim, T. H., Choi, J. Y., Kwon, Y. J., Choi, D. H., Kim, K. C., et al. (2018). Predictors for amputation in patients with diabetic foot wound. *Vascular Specialist International*, *34*(4), 109. https://doi.org/10.5758/vsi.2018.34.4.109.

Lam, H. C. Y., Chan, J. C. N., Luk, A. O. Y., Chan, E. Y. Y., & Goggins, W. B. (2018). Short-term association between ambient temperature and acute myocardial infarction hospitalizations for diabetes mellitus patients: A time series study. *PLoS Medicine*, *15*(7), e1002612. https://doi.org/10.1371/journal.pmed.1002612.

Li, Y. H., Luo, S. Q., Lan, L., Jin, M. G., Yang, C., He, J. Y., et al. (2017). Influence of extreme weather on years of life lost due to diabetes death in Chongqing and Harbin, China. *Zhonghua liu Xing Bing xue za zhi= Zhonghua Liuxingbingxue Zazhi*, *38*(3), 303-308. https://doi.org/10.3760/cma.j.issn.0254-6450.2017.03.006.

Luan, G. J., Yin, P., Wang, L. J., & Zhou, M. G. (2018). An observational study of high air temperature on diabetes mortality in six cities in China. *Zhonghua liu Xing Bing xue za zhi= Zhonghua Liuxingbingxue Zazhi*, *39*(5), 646-650. https://doi.org/10.3760/cma.j.issn.0254-6450.2018.05.020.

Niakan, M. H., Dehghankhalili, M., Pourdavood, A., Vahidi, A., Nazemi, S., Piranviseh, A., et al. (2020). Clinical outcome and determinants of amputation in a large cohort of Iranian patients with diabetic foot ulcers. *The Foot*, 45, 101688. https://doi.org/10.1016/j.foot.2020.101688.

Petrofsky JS. (2011). The effect of type-2-diabetes-related vascular endothelial dysfunction on skin physiology and activities of daily living. *Journal of Diabetes Science and Technology*, *5*(3):657-67. https://doi.org/10.1177/193229681100500319.

Phung, D., Thai, P. K., Guo, Y., Morawska, L., Rutherford, S., & Chu, C. (2016). Ambient temperature and risk of cardiovascular hospitalization: An updated systematic review and meta-analysis. *Science of The Total Environment*, 550, 1084-1102. https://doi.org/10.1016/j.scitotenv.2016.01.154.

Ponirakis, G., Elhadd, T., Chinnaiyan, S., Dabbous, Z., Siddiqui, M., Al-muhannadi, H., et al. (2020). Prevalence and management of diabetic neuropathy in secondary care in Qatar. *Diabetes/Metabolism Research and Reviews*, *36*(4), e3286. https://doi.org/10.1002/dmrr.3286.

Preston, E. V., Eberle, C., Brown, F. M., & James-Todd, T. (2020). Climate factors and gestational diabetes mellitus risk–a systematic review. *Environmental Health*, *19*(1), 1-19. https://doi.org/10.1186/s12940-020-00668-w

Reardon R, Simring D, Kim B, Mortensen J, Williams D, Leslie A. (2020). The diabetic foot ulcer. *Australian Journal of General Practice*, *49*(5):250-255. https://doi.org/10.31128/AJGP-11-19-5161

Seposo, X. T., Dang, T. N., & Honda, Y. (2017). How does ambient air temperature affect diabetes mortality in tropical cities?. *International Journal of Environmental Research and Public Health*, *14*(4), 385. https://doi.org/10.3390/ijerph14040385.

Staiger, H., Schaeffeler, E., Schwab, M., & Häring, H. U. (2015). Pharmacogenetics: implications for modern type 2 diabetes therapy. *The Review of Diabetic Studies: RDS*, *12*(3-4), 363. https://doi.org/10.1900/RDS.2015.12.363

Vallianou, N. G., Geladari, E. V., Kounatidis, D., Geladari, C. V., Stratigou, T., Dourakis, S. P., et al. (2021). Diabetes mellitus in the era of climate change. *Diabetes & Metabolism*, *47*(4), 101205. https://doi.org/10.1016/j.diabet.2020.10.003

Walsh, J. W., Hoffstad, O. J., Sullivan, M. O., & Margolis, D. J. (2016). Association of diabetic foot ulcer and death in a population-based cohort from the United Kingdom. *Diabetic Medicine*, *33*(11), 1493-1498. https://doi.org/10.1111/dme.13054

Weather Underground [online]. Erişim: 20.11. 2020. http://www.wunderground.com.

WHO. Diabetes [online]. Erişim: 14.112022. https://www.who.int/health-topics/diabetes#tab=tab_1.

Zukic, E., Gojak, R., Novakovic, A., & Gazibera, B. (2015). Predictive role of preventive measures in preventing the progression of diabetic foot. *Materia Socio-Medica*, *27*(4), 234. https://doi.org/10.5455/msm.2015.27.234-236