



Original Research / Orijinal Araştırma

Association Between the Peripheral Perfusion Index and Chronic Diseases and Clinical Variables: A Cross-Sectional Study

Periferik Perfüzyon İndeksi ile Kronik Hastalıklar ve Klinik Değişkenler Arasındaki İlişki: Kesitsel Bir Çalışma

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Abstract

Introduction: The peripheral perfusion index (PPI) is a non-invasive and easily applicable parameter that reflects microcirculatory status. Endothelial dysfunction and microvascular impairment observed in chronic diseases may influence PPI values. This study aimed to evaluate the association between PPI and chronic diseases as well as clinical variables in adult individuals.

Methods: This descriptive, cross-sectional study was conducted between December 1, 2021, and February 28, 2022, among adults aged 18–65 years attending an outpatient clinic. Sociodemographic characteristics, chronic disease history, and vital signs were recorded. PPI was measured using a pulse oximeter on the second finger of the right hand at the 20th, 40th, and 60th seconds, and the mean value was analyzed. Nonparametric statistical tests were applied.

Results: A total of 327 participants were included, with a mean age of 46.8±10.9 years; 79.8% were female. PPI showed weak positive correlations with age, body temperature, and body mass index, and weak negative correlations with heart rate and oxygen saturation ($p<0.05$). Diabetes mellitus was significantly associated with PPI ($p=0.005$), whereas no significant associations were observed with overall chronic disease presence, hypertension, asthma/COPD, or cardiovascular diseases.

Conclusion: PPI is associated with several clinical and physiological variables in adults and may serve as a potential indicator of microvascular alterations, particularly in individuals with diabetes. Further studies are warranted to clarify the clinical utility of PPI in chronic diseases.

Keywords: Peripheral perfusion index, Chronic Disease, Microcirculation, Hemodynamic Parameters, Pulse oximetry

Özet

Giriş: Periferik perfüzyon indeksi (PPI), mikrosirkülasyonu yansıtan noninvaziv ve kolay uygulanabilir bir parametredir. Kronik hastalıklarda görülen endotelial disfonksiyon ve mikrovasküler bozulmaların PPI üzerinde etkili olabileceği düşünülmektedir. Bu çalışmanın amacı, erişkin bireylerde PPI değerlerinin kronik hastalıklar ve klinik değişkenlerle ilişkisini değerlendirmektir.

Yöntem: Bu tanımlayıcı ve kesitsel çalışma 01.12.2021 ile 28.02.2022 tarihleri arasında polikliniğe başvuran 18–65 yaş arası bireylerde yürütülmüştür. Sosyodemografik özellikler, kronik hastalık öyküleri ve vital bulgular kaydedilmiştir. PPI ölçümü pulse oksimetre ile sağ el ikinci parmakta 20., 40. ve 60. saniyelerde yapılmış ve ortalaması analize alınmıştır. İstatistiksel analizlerde nonparametrik testler kullanılmıştır.

Bulgular: Çalışmaya 327 katılımcı dahil edilmiş olup yaş ortalaması 46,8±10,9 yıl ve %79,8'i kadındı. PPI ile yaş, vücut sıcaklığı ve beden kitle indeksi arasında pozitif; nabız ve oksijen saturasyonu arasında negatif yönde zayıf korelasyon saptandı ($p<0,05$). Diyabet varlığı PPI ile anlamlı ilişkili bulunurken ($p=0,005$), toplam kronik hastalık varlığı, hipertansiyon, astım/KOAH ve kardiyovasküler hastalıklar ile anlamlı ilişki saptanmadı.

Sonuç: PPI, erişkin bireylerde çeşitli klinik ve fizyolojik değişkenlerle ilişkili olup özellikle diyabetli bireylerde mikrovasküler değişiklikleri yansıtabilecek potansiyel bir parametre olarak değerlendirilebilir. Kronik hastalıklarda PPI'nın klinik kullanımını netleştirmek için ileri çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Periferik perfüzyon indeksi, Kronik hastalıklar, Mikrosirkülasyon, Pulse oksimetri, Hemodinamik parametreler

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Introduction

Chronic diseases have become an increasingly important public health problem worldwide. Population aging, lifestyle changes, environmental exposures, and behavioral risk factors have substantially increased the prevalence of conditions requiring long-term care, such as hypertension, diabetes mellitus, chronic respiratory diseases, and cardiovascular diseases. These conditions, which necessitate prolonged medical follow-up, lead to marked increases in morbidity, mortality, and healthcare system costs, thereby imposing a growing burden on individuals and societies.^{1,2}

Metabolic dysregulation, endothelial injury, autonomic nervous system imbalance, and impaired circulation at the microvascular and macrovascular levels are common pathophysiological processes in chronic diseases. In this context, the assessment of peripheral microcirculation using an objective and noninvasive parameter is of clinical value for the early identification of disease severity, tissue perfusion status, and overall hemodynamic adequacy.^{3,4}

The peripheral perfusion index (PPI) is an easily applicable indicator of real-time peripheral perfusion, calculated as the ratio of the pulsatile (AC) to nonpulsatile (DC) components of blood flow measured by pulse oximetry ($AC/DC \times 100$). PPI reflects key hemodynamic components, including cardiac output, vascular tone, and autonomic activity (5). Previous studies have reported that low PPI values are associated with tissue hypoperfusion, disease severity, the need for intensive care, and mortality; moreover, in certain clinical settings, PPI has been shown to detect perfusion abnormalities earlier than lactate levels.^{6,7}

In individuals with chronic diseases, processes such as endothelial dysfunction, arterial stiffness, microvascular injury, and autonomic dysfunction constitute the main mechanisms that may lead to a reduction in PPI values.⁸ In hypertension, recurrent episodes of elevated blood pressure damage the vascular wall, whereas in diabetes mellitus, microangiopathy and neurovascular alterations impair tissue perfusion.⁹ In chronic respiratory diseases such as asthma and chronic obstructive pulmonary disease, vascular changes related to systemic inflammation and hypoxia are observed, while in cardiovascular diseases, significant perfusion impairment may occur at both macrovascular and microvascular levels.¹⁰⁻¹²

Nevertheless, data regarding the impact of chronic diseases on the peripheral perfusion index remain limited, and the relationship between PPI values measured during outpatient clinic visits and the presence of chronic disease has not been sufficiently investigated. Determining whether peripheral microcirculation reflects the burden of chronic disease may contribute to early risk stratification and clinical decision-making processes. Therefore, this study aimed to investigate whether peripheral perfusion index values are lower in individuals with chronic diseases compared with those without chronic disease.

Materials and Methods

Study Design

This study was designed as a cross-sectional investigation conducted at the Family Medicine Outpatient Clinics of Ankara Training and Research Hospital, Health Science University between December 1, 2021, and February 28, 2022. Data were collected prospectively from individuals attending the outpatient clinic during the study period. Individuals aged 18–65 years who provided written informed consent at the time of admission and met none of the exclusion criteria were included in the study.

Inclusion Criteria

The study included individuals who met the following criteria:

- Aged between 18 and 65 years,
- Attended the outpatient clinic for any reason,
- Had no communication impairments,
- Provided written informed consent.

Exclusion Criteria

Individuals meeting any of the following criteria were excluded from the study:

- Pregnancy,
- Known peripheral vascular disease,
- Presence of local infection, burn, wound, or a history of surgical intervention in the extremity used for PPI measurement,
- Nail polish, artificial nails, or adhesive materials on the fingers that could interfere with sensor placement,
- Suspected severe anemia (hemoglobin <8 g/dL) or significant hypovolemia that could affect diagnostic measurements,
- Use of supplemental oxygen or presence of acute respiratory distress,
- Use of peripheral vasoconstrictor or vasodilator medications within the previous 8 hours (e.g., nitrates, recent changes in β -blocker therapy, alpha-agonists),

- Exposure to cold, hypothermia, or hyperthermia that could impair digital circulation,
- Cognitive impairment severe enough to preclude independent completion of the questionnaire,
- Refusal to continue participation or withdrawal of informed consent at any stage of the study.

Given the cross-sectional study design, no formal sample size calculation was performed, and all eligible participants meeting the inclusion criteria during the study period were targeted for enrollment.

Data Collection Process

Data were collected through face-to-face interviews using a standardized data collection form developed by the investigators. Sociodemographic characteristics (age, sex, marital status, educational level, occupation, smoking status, and body mass index) and existing chronic disease histories were recorded for each participant. All measurements were performed after the participants had rested for at least 5 minutes, under identical physical conditions, in a seated position, and using the same equipment. This rigorous standardization was implemented to minimize potential systematic measurement bias. Information regarding chronic diseases, including hypertension, diabetes mellitus, chronic obstructive pulmonary disease (COPD)/asthma, and cardiovascular diseases, was obtained through face-to-face interviews with participants and verified using the hospital's electronic medical record system. Blood pressure, heart rate, respiratory rate, oxygen saturation, and body temperature were measured sequentially. The peripheral perfusion index was measured on the second finger of the right hand using a COMFORT PLUS M170 (approved by the Turkish Medicines and Medical Devices Agency) pulse oximeter at the 20th, 40th, and 60th seconds, and the mean of these three measurements was included in the analysis. No additional tests or interventions that could impose extra financial burden on participants were performed; only measurements routinely obtained during standard clinical evaluation were used.

Ethical Approval

This study was approved by the Clinical Research Ethics Committee of Ankara Training and Research Hospital, Health Science University, on December 22, 2021 (approval No: 835/2021). All procedures were conducted in accordance with the principles of the Declaration of Helsinki and the guidelines for Good Clinical Practice.

Statistical Analysis

Categorical variables were expressed as numbers and percentages. Continuous variables were assessed for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests and, as they did not follow a normal distribution, were reported as median (minimum–maximum). The Mann–Whitney U test was used for comparisons between two groups, and the Kruskal–Wallis test was applied for comparisons among three or more groups. Relationships between continuous variables were evaluated using the Spearman's correlation analysis. All statistical analyses were performed using IBM SPSS Statistics version 25, and a p value <0.05 was considered statistically significant. Because the study was conducted as a cross-sectional investigation within a predefined study period, a formal a priori sample size calculation was not performed. All eligible participants attending the outpatient clinic during the study period were included in the study. A post hoc power analysis based on the observed association between peripheral perfusion index and diabetes mellitus indicated that the sample size of 327 participants provided adequate statistical power at an alpha level of 0.05.

Results

A total of 327 participants were included in the study. The mean age was 46.8 ± 10.9 years, and 79.8% of the participants were female. The detailed distribution of sociodemographic characteristics is presented in Table 1.

Table 1. *Distribution of Sociodemographic Characteristics of the Participants*

Sociodemographic Characteristics		n (%)
Age, median (min–max)		47 (19 – 65)
Gender	Female	261 (79,8)
	Male	66 (20,2)
Marital status	Married	267 (81,7)
	Single	29 (8,9)
	Widowed / Divorced	31 (9,5)
Educational level	Literate	12 (3,7)
	Primary school	150 (45,9)
	Secondary school	48 (14,7)
	High school	66 (20,2)
	University or higher	51 (15,6)
Occupation	Unemployed	8 (2,4)
	Homemaker	184 (56,3)
	Student	6 (1,8)
	Worker	62 (19)
	Self-employed	10 (3,1)
	Civil servant	18 (5,5)
	Retired	39 (11,9)

Among the participants, 22.6% had hypertension, 14.1% had diabetes mellitus, 9.5% had asthma/COPD, 6.1% had cardiovascular disease, and 14.7% had other chronic diseases (Table 2).

Table 2. *Distribution of Chronic Diseases and Smoking Status of the Participants*

		n (%)
Presence of chronic disease	Yes	146 (44,6)
	No	181 (55,4)
Smoking status	Yes	93 (28,4)
	No	177 (54,1)
	Former smoker	57 (17,4)
Hypertension	Present	74 (22,6)
	Absent	253 (77,4)
Diabetes mellitus	Present	46 (14,1)
	Absent	281 (85,9)
Pulmonary disease (COPD/Asthma)	Present	31 (9,5)
	Absent	296 (90,5)
Cardiovascular disease	Present	20 (6,1)
	Absent	307 (93,9)
Other diseases	Present	48 (14,7)
	Absent	279 (85,3)

COPD: Chronic Obstructive Pulmonary Disease.

Weak positive correlations were identified between PPI values and age ($p = 0.048$), body temperature ($p < 0.001$), and body mass index (BMI) ($p < 0.001$), whereas weak negative correlations were observed with heart rate ($p < 0.001$) and oxygen saturation ($p < 0.001$). No significant association was found between PPI and respiratory rate ($p = 0.411$). Correlation analyses are summarized in Table 3.

Table 3. Evaluation of the Association Between PPI Values and Age and Vital Signs of the Participants

Association Between PPI Values and Age and Vital Signs	Coefficient	p value*
Age*PPI	0,179	0,048
Heart rate*PPI	-0,197	<0,001
SpO ₂ *PPI	-0,314	<0,001
Respiratory rate*PPI	-0,046	0,411
Body temperature*PPI	0,210	<0,001
BMI*PPI	0,217	<0,001

PPI: Peripheral Perfusion Index, BMI: Body Mass Index.

*Spearman correlation analysis. $p < 0.05$ was considered statistically significant.

When sociodemographic variables were evaluated, a significant difference was observed between educational level and PPI ($p = 0.017$), with lower PPI values detected in university graduates compared with primary and high school graduates. No significant associations were found between PPI and sex, marital status, or occupation ($p > 0.05$). Participants reporting a sensation of coldness (“hands/feet usually feel cold” or “feeling excessively cold in cold environments”) had significantly lower PPI values (both $p = 0.001$), whereas complaints of numbness or burning in the hands or feet were not associated with PPI ($p = 0.393$) (Table 4).

Table 4. Evaluation of the Association Between PPI Values and Sociodemographic Characteristics and Symptoms of the Participants

Sociodemographic Characteristics and Symptoms (n = 327)	Peripheral Perfusion Index		p value
	Median	Min - Max	
Gender			0,312 ^a
Female (n=261)	4,4	0,8 – 18,0	
Male (n=66)	3,7	0,5 – 14,0	
Marital status			0,553 ^b
Married (n=267)	4,1	0,5 – 18,0	
Single (n=29)	4,0	1,0 – 10,0	
Widowed / Divorced (n=31)	5,1	1,0 – 13,0	
Educational level			0,017^b
Literate (n = 12)	5,1	1,2 – 6,9	
Primary school (n = 150)	4,8	1,0 – 18,0	
Secondary school (n = 48)	4,3	0,5 – 13,0	
High school (n = 66)	3,6	0,9 – 11,0	
University (n = 51)	3,5	0,8 – 10,0	
Occupation			0,699 ^b
Homemaker (n = 184)	4,5	1,0 – 18,0	
Employed (n = 90)	3,8	0,8 – 13,0	
Retired (n = 39)	4,4	0,5 – 14,0	
Student/Unemployed (n = 14)	3,8	1,6 – 8,8	
Hands and feet are usually cold			0,001^a
Yes (n = 117)	3,6	0,5 – 14,0	
No (n = 210)	4,8	1,0 – 18,0	
Hands and feet are very sensitive to cold exposure			0,001^a
Yes (n = 117)	3,6	0,5 – 14,0	
No (n = 210)	4,8	1,0 – 18,0	
Numbness, tingling, or burning sensation in the hands and feet			0,393 ^a
Yes (n = 122)	4,6	0,9 – 18,0	
No (n = 205)	4,1	0,5 – 17,0	

a: Mann–Whitney U test, b: Kruskal–Wallis test. $p < 0.05$ was considered statistically significant.

Among clinical characteristics, smoking status ($p = 0.021$) and the presence of diabetes mellitus ($p = 0.005$) were significantly associated with PPI. In contrast, no significant associations were observed between PPI and overall presence of chronic disease ($p = 0.334$), hypertension ($p = 0.634$), asthma/COPD ($p = 0.228$), cardiovascular disease ($p = 0.913$), other chronic diseases ($p = 0.638$), or a history of COVID-19 ($p = 0.753$) (Table 5).

Table 5. Evaluation of the Association Between PPI Values and Medical Characteristics of the Participants

Medical Characteristics (n:327)	Peripheral Perfusion Index		p value*
	Median	Min - Max	
Smoking status			0,021
Yes (n=93)	5,0	0,9 – 14,0	
No (n=177)	4,0	0,8 – 17,0	
Presence of chronic disease			0,334
Present (n=146)	4,8	0,8 – 14,0	
Absent (n=181)	4,0	0,5 – 18,0	
Hypertension			0,634
Present (n=74)	4,4	1,0 – 14,0	
Absent (n=253)	4,2	0,5 – 18,0	
Diabetes mellitus			0,005
Present (n=46)	6,1	1,0 – 13,0	
Absent (n=281)	4,1	0,5 – 18,0	
COPD/Asthma			0,228
Present (n=31)	4,9	1,1 – 12,0	
Absent (n=296)	4,1	0,5 – 18,0	
Cardiovascular disease			0,913
Present (n=20)	4,2	1,1 – 14,0	
Absent (n=307)	4,4	0,5 – 18,0	
Other diseases			0,638
Present (n=48)	4,9	0,8 – 12,0	
Absent (n=279)	4,1	0,5 – 18,0	
COVID-19 infection			0,753
Yes (n=60)	4,1	0,5 – 12,0	
No (n=267)	4,4	0,8 – 18,0	

COPD: Chronic Obstructive Pulmonary Disease.

*Mann–Whitney U test. $p < 0.05$ was considered statistically significant.

Discussion

The present study evaluated the relationship between peripheral perfusion index and various sociodemographic and clinical variables in an outpatient population. The findings demonstrated that PPI was associated with several physiological parameters, including age, body temperature, body mass index, heart rate, and oxygen saturation. In addition, certain clinical characteristics such as smoking status and the presence of diabetes mellitus showed significant associations with PPI, whereas no significant relationships were observed with several other chronic diseases. These findings contribute to the growing body of evidence suggesting that PPI may reflect multiple physiological and clinical factors influencing peripheral microcirculation.

In our study, a positive relationship was observed between age and PPI. This contradicts the negative correlation reported by Okada et al. in a sample of 1080 individuals.¹³ This discrepancy can be explained by heterogeneity in sample distributions, differences in measurement devices, environmental factors, and variations in measurement timing. In addition, the fact that individuals in the highest PPI quartile are younger suggests that the relationship between age and PPI may not be linear.

The negative correlation observed between PPI and heart rate is consistent with both physiological expectations and findings reported in the literature. As demonstrated in the studies by Okada and Hasanin, increased sympathetic tone leads to pronounced peripheral vasoconstriction, resulting in reduced PPI values and thereby supporting a negative association with heart rate.^{14,15} This finding is also in agreement with the study by Siber et

al., which highlighted the potential role of PPI in emergency department triage and early risk stratification.⁶ In that study, PPI was emphasized as an early indicator of circulatory insufficiency and hemodynamic instability. The heart rate–PPI relationship observed in the present study suggests that this clinical mechanism may also be applicable in a community-based population.

In our study, a negative association was identified between SpO₂ and PPI. Some studies in the literature have reported a positive correlation, attributing this finding to differences in peripheral vasodilation and vasoconstriction related to pH changes.^{16,17} However, reports of only weak positive correlations in heterogeneous populations indicate partial inconsistency with our results. This discrepancy may be related to factors such as the clinical context in which measurements were obtained, environmental variables influencing patients' perfusion status, or a broader physiological spectrum among the study population.

The positive association between PPI and body temperature observed in our study is consistent with the findings of Wang et al., who examined vasoconstrictive mechanisms triggered by peripheral heat loss.¹⁸ Similarly, lower PPI values among individuals reporting coldness of the hands and feet support the role of thermoregulation in influencing peripheral perfusion.

The positive correlation between BMI and PPI is in line with previous reports and suggests that the relationship between body composition and microcirculation may be reflected through PPI measurements.^{13,19} Notably, the association between educational level and PPI identified in our study has not, to our knowledge, been extensively evaluated in the existing literature. Therefore, this finding should be interpreted cautiously. The observed difference may reflect underlying sociodemographic or behavioral factors that were not directly assessed in the present study. Further research is needed to clarify whether educational level has an independent relationship with PPI.

In our study, the significant difference observed between smoking status and PPI indicated higher PPI values among smokers, a finding that contrasts with previous reports suggesting that exposure to carbon monoxide from tobacco products may reduce peripheral perfusion index. This discrepancy may be related to methodological differences between studies. In particular, the lack of standardization regarding the timing of smoking prior to measurement may influence peripheral perfusion values. In some studies evaluating PPI, measurements were performed following standardized resting periods, whereas variations in the duration of rest before measurement may affect peripheral vascular tone and perfusion. In addition, chronic exposure to tobacco smoke may lead to adaptive changes in the microvascular circulation. Long-term smoking has been associated with alterations in endothelial function, autonomic nervous system activity, and vascular reactivity, which may influence peripheral perfusion measurements.^{20,21} Therefore, the higher PPI values observed among smokers in our study should be interpreted cautiously, and further studies using standardized measurement protocols are needed to clarify this relationship.

The significant association between diabetes mellitus and PPI may be attributed to the progressive endothelial dysfunction, autonomic neuropathy, and microvascular circulatory impairment that characterize diabetes, allowing changes in PPI to reflect these underlying pathophysiological processes. This finding is consistent with the results reported by Siber et al., who demonstrated that PPI sensitively reflects systemic physiological deterioration in the prehospital setting, in a manner comparable to the NEWS score, with increased prognostic value particularly in subgroups with impaired perfusion.²¹ In the present study, the observation of higher PPI values among individuals with diabetes, together with the pronounced positive association between BMI and PPI, supports the notion that this pathophysiological framework may also be applicable in a community-based primary care population. These findings suggest that PPI may serve as a potential noninvasive marker for the early detection of microvascular changes in diabetes.

However, this finding should be interpreted with caution. Diabetes mellitus is generally associated with endothelial dysfunction and microvascular impairment, which are expected to reduce peripheral perfusion. The higher PPI values observed in individuals with diabetes in the present study may therefore reflect the influence of additional factors such as disease duration, glycemic control, autonomic nervous system alterations, or variations in peripheral vascular tone. Moreover, the cross-sectional nature of the study limits the ability to establish causal relationships. Consequently, this observation should not be interpreted as evidence of improved peripheral perfusion in individuals with diabetes but rather as a finding that warrants further investigation in larger and more controlled studies.

The absence of a significant difference in PPI with respect to chronic obstructive pulmonary disease (COPD) is consistent with studies reporting that COPD alone does not markedly alter the peripheral perfusion index.²² In the stable phase of COPD, microvascular perfusion is largely preserved, allowing PPI values to remain within normal ranges. This suggests that COPD may significantly affect peripheral perfusion primarily during periods of acute inflammation, hypoxemia, or hemodynamic stress.

Similarly, the lack of a significant difference in PPI among individuals with cardiovascular disease may be explained by the preservation of peripheral microcirculation during stable disease states. In the absence of acute hemodynamic stress, cardiac output and peripheral vascular tone can be maintained through compensatory mechanisms. Moreover, a review of the literature indicates a paucity of comprehensive and original studies evaluating the extent to which PPI reflects perfusion status in patients with stable cardiovascular disease.

Although PPI has been shown to be a valuable prognostic marker reflecting disease severity and hemodynamic impairment during the acute phase of COVID-19, the recovery phase of the infection is characterized by the restoration of endothelial function and normalization of microvascular perfusion as part of the expected pathophysiological process.²³ Therefore, the absence of significant differences in PPI during the post-acute period represents a clinically predictable finding.

Overall, our findings demonstrate that PPI is significantly associated with age, vital signs, thermoregulation, metabolic status, and certain chronic diseases. Results that are inconsistent with the existing literature may be attributable to factors such as differences in sample characteristics, the clinical context in which measurements were obtained, and participant heterogeneity. Nevertheless, by elucidating the physiological and clinical determinants of PPI in a large, community-based population, this study contributes valuable data to the current literature.

Limitations

The present study has several limitations that should be acknowledged. First, the study population consisted predominantly of female participants (approximately 80%), which may reflect healthcare utilization patterns in primary care settings where women tend to seek medical care more frequently for preventive services and chronic disease monitoring. Although participants were consecutively recruited from individuals attending the outpatient clinic during the study period, this imbalance may limit the generalizability of the findings, particularly to male populations. Second, the cross-sectional design of the study precludes the establishment of causal relationships between PPI and the evaluated clinical variables. Furthermore, the study was conducted in a single center, which may limit the external validity of the findings. Third, the statistical analysis primarily relied on univariate comparisons and correlation analyses. Although several variables that may influence peripheral perfusion, such as age, body mass index, and smoking status, were evaluated, multivariable regression models were not performed. Therefore, the potential influence of confounding variables cannot be fully excluded. PPI measurements may also be influenced by environmental and physiological factors such as room temperature, ambient conditions, and individual stress levels, which were not systematically controlled in the present study.

Finally, the timing of smoking prior to PPI measurement was not standardized. The interval between the last cigarette and the measurement was not recorded, and although measurements were performed after a resting period, variations in the duration of rest may have influenced peripheral perfusion values. Therefore, the relationship between smoking status and PPI observed in this study should be interpreted with caution. Future multicenter studies with larger and more balanced populations and standardized measurement protocols are warranted to further clarify the relationship between PPI and chronic diseases.

Conclusion

This study evaluated the association between the peripheral perfusion index and sociodemographic as well as clinical variables in a community-based sample. PPI was found to be positively associated with age, body temperature, BMI, and educational level, and negatively associated with heart rate and SpO₂. Although the overall presence of chronic diseases did not have a significant impact on PPI, the significantly higher PPI values observed among individuals with diabetes are noteworthy and suggest that PPI may serve as a potential biomarker for the early detection of microvascular changes associated with diabetes. PPI may also be considered a complementary parameter in the assessment of microvascular effects related to smoking and obesity. As a noninvasive and easily applicable method, further large-scale and controlled studies are warranted to clarify the role of PPI in the early evaluation of tissue perfusion in chronic diseases.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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