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The Effect of Ramadan Fasting on Skin Autofluorescence Levels as a Marker of Advanced Glycation End Products in Adults

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Article

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Abstract

Advanced glycation end products (AGEs) are bioactive compounds implicated in oxidative stress, inflammation, and the development of chronic diseases. Skin autofluorescence (SAF) is a validated, non-invasive technique used to estimate tissue AGE accumulation. Ramadan fasting (RF), a form of time-restricted intermittent fasting, may influence metabolic, inflammatory, and glycation-related pathways; however, its effects on tissue AGE accumulation remain insufficiently understood. This study aimed to investigate the effect of RF on SAF levels and selected anthropometric parameters in healthy adults.

A total of 58 participants were included in this prospective observational longitudinal study. Measurements were obtained at three time points: pre-Ramadan (T0), mid-Ramadan (T15), and post-Ramadan (T30). Anthropometric variables, body composition parameters, and SAF levels were assessed using standardized methods. Statistical analyses were performed using repeated-measures analysis of variance and independent samples tests.

No statistically significant effects of time, group, or group × time interaction were observed for body weight, body mass index, body fat percentage, muscle mass, total body water percentage, waist-to-height ratio, waist-to-hip ratio, or SAF levels ($p > 0.05$). Although modest downward trends in body weight, body mass index, and SAF levels were observed during Ramadan in the fasting group, all observed effect sizes were trivial and the changes were neither statistically nor clinically meaningful.

In conclusion, Ramadan fasting did not significantly affect SAF levels or anthropometric parameters in young and generally healthy adults. Considering that SAF reflects long-term AGE accumulation, the absence of measurable alterations following a relatively short fasting period may be biologically plausible. Further longitudinal studies involving metabolically diverse populations and incorporating detailed nutritional assessment are needed to clarify the potential relationship between Ramadan fasting and AGE metabolism.

Introduction

Advanced glycation end products (AGEs) are formed through non-enzymatic reactions between the amino groups of proteins, lipids, and nucleic acids and the carbonyl groups of reducing sugars [1]. AGEs are generated endogenously within the body and also contribute to the systemic AGE pool through exogenous sources, particularly dietary intake. Increased AGE accumulation can impair the structural and functional integrity of proteins, leading to cellular damage and activating proinflammatory signaling pathways, thereby contributing to various pathophysiological processes [2]. The literature has demonstrated that AGE accumulation is associated with type 2 diabetes mellitus (T2DM), cardiovascular diseases (CVD), Alzheimer's disease (AD), and malignancies [3, 4].

The assessment of AGE levels in body fluids and tissues is performed using various analytical approaches. In the skin, AGE accumulation is evaluated non-invasively through SAF, a method based on the intrinsic fluorescent properties of AGEs [5]. This technique measures the fluorescence emitted by

AGE-related compounds, particularly pentosidine and similar fluorophores, upon excitation with ultraviolet light [6, 7]. Due to its simplicity, rapidity, and non-invasive nature, SAF is considered a practical and reliable biomarker for assessing tissue AGE burden. Recent studies suggest that SAF may reflect systemic AGE accumulation and serve as a clinically relevant indicator for the assessment of T2DM and CVD risk [8]. RF is a model of intermittent fasting characterized by abstinence from food and drink from dawn to sunset for approximately 12–15 hours daily over a one-month period according to the Hijri calendar. In recent years, the metabolic and physiological effects of RF have gained increasing scientific interest. Prolonged daily fasting induces adaptive changes in hormonal regulation, circadian rhythm, and energy metabolism, and may exert modulatory effects on inflammatory processes [9, 10, 11]. However, the impact of RF on systemic AGE burden remains insufficiently elucidated. In particular, the limited number of studies directly investigating the relationship between RF and AGE levels assessed by SAF highlights the need for further research in this area.

The aim of this study is to investigate the effect of Ramadan fasting on SAF levels. Additionally, the study seeks to evaluate potential changes in SAF following the fasting period and to provide insights into possible implications for cardiovascular disease risk.

Materials and Methods

Study design

This study was designed as a prospective observational longitudinal study to evaluate the effects of Ramadan fasting on skin autofluorescence (SAF) levels and anthropometric parameters in healthy adults. Measurements were obtained at three predefined time points before, during, and after Ramadan in both fasting and non-fasting participants.

Participants

A total of 68 volunteers were initially recruited from a foundation university during the 2024–2025 Spring Semester using convenience sampling. During follow-up, 6 participants from the fasting group and 4 participants from the control group were excluded due to missed measurements at one or more study time points. Consequently, the final analyses included 58 participants (43 women and 15 men), including 29 individuals in the fasting group (FG) and 29 individuals in the control group (CG), all of whom completed measurements at T0, T15, and T30.

Inclusion and exclusion criteria are as follows:

Inclusion criteria:

- Individuals aged 18 years and older

- Due to the technical limitations of the SAF measurement device, absence of dark skin pigmentation, tattoos, or scars on the inner side of the arm
- No history of chronic disease, pregnancy, or eating disorders
- Signed informed consent form

Exclusion criteria:

- Individuals under 18 years of age
- Presence of dark skin pigmentation (due to the technical limitations of the skin autofluorescence device), tattoos, or scars on the inner side of the arm
- Presence of any chronic diseases, pregnancy, or a history of eating disorders
- Absence of a signed informed consent form

The data collection process was carried out in three different periods: before Ramadan, in the middle of Ramadan, and at the end of Ramadan. The first measurements were taken 1 week before Ramadan (T0), the second measurements were obtained during mid-Ramadan (T15), and the third measurements were performed within 1 month after Ramadan (T30). Figure 1 shows a summary of the methodology.

Measures

Within the scope of the study, demographic data included sex, age, smoking status, and alcohol consumption. Height measurements were obtained using a stadiometer (Portstad HM200P Portable Stadiometer, Charder, Taichung City, Taiwan) in a standardized anthropometric position. Waist and hip circumferences were measured by the researchers using a non-elastic measuring tape.

Body weight, body fat percentage (BFP), muscle mass, and total body water percentage (TBW%) were assessed using bioelectrical impedance analysis (BIA) with a Tanita SC-330 device (Tanita Corporation, Tokyo, Japan). Measurements were performed with participants in a fasted state during both pre-Ramadan and post-Ramadan periods, wearing light clothing, barefoot, and standing on a stable surface under standardized conditions.

Body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (m^2). According to the World Health Organization (WHO) classification, BMI values were categorized as underweight (< 18.5 kg/m^2), normal weight (18.5–25.0 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30 kg/m^2). Waist-to-height ratio (WHtR) and waist-to-hip ratio (WHR) were also calculated.

Participants' skin SAF levels were measured using the AGE Reader device (DiagnOptics Technologies, Groningen, Netherlands). Measurements were performed on the forearm of the dominant upper extremity, approximately 10–15 cm distal to the antecubital fossa, with participants in a seated position

under standardized conditions. The AGE Reader is a non-invasive, portable device that assesses the accumulation of AGEs in the skin by utilizing their characteristic autofluorescent properties [12].

The measurement principle of the device is based on the application of excitation light at a peak wavelength of approximately 370 nm (within the 300–420 nm range) onto the skin surface (Fig. 2). SAF is calculated as the ratio of emitted fluorescent light in the 420–600 nm wavelength range to the excitation light in the 300–420 nm range, and is expressed in arbitrary units (AU) [12].

All measurements were performed under standardized conditions by trained researchers using the same equipment and measurement protocols throughout the study period in order to minimize measurement variability.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics software (Version 25.0, IBM Corp., Armonk, NY, USA). The normality of data distribution was assessed using the Kolmogorov–Smirnov/Shapiro–Wilk tests and visual inspection methods. Assumptions of repeated-measures ANOVA, including sphericity, were evaluated prior to analysis. When the assumption of sphericity was violated, Greenhouse–Geisser corrections were applied. Continuous variables were expressed as mean ± standard deviation (SD) or median (minimum–maximum) where appropriate, while categorical variables were presented as number and percentage.

Baseline comparisons between groups were performed using the independent samples t-test for normally distributed variables and the chi-square test for categorical variables. Longitudinal changes in anthropometric measurements and SAF levels across the three time points (T0, T15, and T30) were evaluated using repeated-measures analysis of variance (ANOVA). Time effect, group effect, and group × time interaction were examined. Effect sizes were calculated using Cohen's d for between-group comparisons and partial eta squared (η^2) for repeated-measures analyses and interaction effects. A two-tailed p-value < 0.05 was considered statistically significant.

This manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Results

General demographic and anthropometric characteristics of the participants are presented in Table 1. A total of 58 individuals participated in the study, including 43 women and 15 men. The median age of the participants was 24.0 years (min–max: 19–50), and there was no statistically significant difference between women and men in terms of age ($p = 0.313$). Mean BMI was significantly higher in men than in women (27.75 ± 0.60 kg/m² vs. 23.78 ± 0.52 kg/m², respectively; $p < 0.001$). According to BMI classification, 31 participants were in the normal BMI range, whereas 16 were overweight and 8 were classified as obese ($p < 0.001$).

BFP was significantly higher in women compared with men (25.85 ± 9.92% vs. 20.86 ± 6.06%; $p < 0.001$). In contrast, muscle mass was significantly higher in men than in women (60.93 ± 14.36 kg vs. 43.01 ± 6.74 kg; $p < 0.001$). Similarly, TBW% was significantly greater in men than in women (55.56 ± 4.38% vs. 51.80 ± 6.40%; $p < 0.001$). In addition, both WHtR and WHR were significantly higher in men compared with women ($p < 0.001$).

The mean SAF level of the participants was 1.58 ± 0.30 AU. Although women had higher SAF levels than men (1.61 ± 0.30 AU vs. 1.52 ± 0.30 AU), the difference was not statistically significant ($p > 0.05$).

Baseline anthropometric characteristics and SAF measurements of the FG and CG are presented in Table 2. Comparative analyses demonstrated that there were no statistically significant differences between the groups at baseline with respect to body weight, BMI, body fat percentage, muscle mass, total body water percentage, waist-to-height ratio, waist-to-hip ratio, or SAF levels (all $p > 0.05$). Furthermore, effect size analyses revealed negligible differences between the groups for all evaluated variables (Cohen's $d < 0.02$), indicating a high degree of baseline homogeneity between the FG and CG prior to the Ramadan fasting period.

At baseline, mean SAF levels were 1.59 ± 0.27 AU in the fasting group and 1.60 ± 0.33 AU in the CG, with no statistically significant difference observed between the groups ($p = 0.931$). Similarly, BMI values were comparable between the FG (24.87 ± 6.05 kg/m²) and the CG (24.82 ± 5.64 kg/m²) ($p = 0.971$). Collectively, these findings indicate that both groups exhibited similar anthropometric and metabolic profiles before the initiation of the study period.

The longitudinal changes in anthropometric characteristics and SAF levels of the FG and CG across the three measurement time points are presented in Table 3. Repeated-measures analyses demonstrated no significant effects of time, group, or group × time interaction for any evaluated variable (all $p > 0.05$). Moreover, all observed effect sizes were trivial (partial $\eta^2 < 0.02$), indicating minimal practical and clinical impact of Ramadan fasting on anthropometric parameters and SAF levels over the study period.

At baseline, body weight was 70.22 ± 20.94 kg in FG and 70.13 ± 20.22 kg in the CG. During the second week of Ramadan, mean body weight in the FG decreased slightly to 69.51 ± 20.96 kg and was 69.89 ± 20.80 kg at the post-Ramadan assessment. In the CG, body weight remained relatively stable throughout the study period (70.33 ± 20.24 kg at T15 and 70.30 ± 20.32 kg at T30). However, these changes were not statistically significant with respect to time effect, group effect, or group × time interaction (all $p > 0.05$). Similar patterns were observed for BMI, body fat percentage, muscle mass, total body water percentage, waist-to-hip ratio, and waist-to-height ratio.

Regarding SAF levels, FG demonstrated mean values of 1.59 ± 0.27 AU at baseline, 1.52 ± 0.24 AU during the second week of Ramadan, and 1.53 ± 0.24 AU at the post-Ramadan assessment. In the CG, SAF levels were 1.60 ± 0.33 AU at baseline, 1.63 ± 0.35 AU at T15, and 1.64 ± 0.36 AU at T30. Although a modest downward trend in SAF levels was observed in the FG during Ramadan, the group × time interaction effect was not statistically significant ($p = 0.592$; $\eta^2 = 0.006$). Likewise, no significant

interaction effects were identified for BMI, waist-to-hip ratio, or waist-to-height ratio, indicating that the temporal changes observed throughout the study period were comparable between the FG and CG.

Table 1
Demographic and anthropometric characteristics of the study participants according to sex

Variables	**Total (n = 58)**	**Female (n = 43)**	**Male (n = 15)**	**p-value**
Age (years) Median (Min-Max)	24.0 (19–50)	24.0 (19–50)	24.0 (19–50)	0.313[a]
BMI (kg/m^2)	24.81 ± 5.76	23.78 ± 0.52	27.75 ± 0.60	< 0.001**
BMI classification n (%)				
Underweight	3(5.2%)	3(7.0%)	0(0.0%)	< 0.001**
Normal	31(53.4%)	27(62.8%)	4(26.7%)	
Overweight	16(27.6%)	9(20.9%)	7(46.7%)	
Obesity	8(13.8%)	4(9.3%)	4(26.7%)	
BFP%	24.56 ± 9.32	25.85 ± 9.92	20.86 ± 6.06	< 0.001**
Muscle mass	47.65 ± 12.17	43.01 ± 6.74	60.93 ± 14.36	< 0.001**
TBW%	52.77 ± 6.16	51.80 ± 6.40	55.56 ± 4.38	< 0.001**
WHtR	0.50 ± 0.09	0.48 ± 0.08	0.56 ± 0.09	< 0.001**
WHR	0.82 ± 0.11	0.78 ± 0.09	0.93 ± 0.07	< 0.001**
SAF (AU)	1.58 ± 0.30	1.61 ± 0.30	1.52 ± 0.30	0.126

Data are presented as mean ± standard deviation or median (minimum–maximum). BMI: Body mass index; BFP: Body fat percentage; TBW: Total body water; WHtR: Waist-to-height ratio; WHR: Waist-to-hip ratio; SAF: Skin autofluorescence; AU: Arbitrary units. *p ≤ 0.05; **p < 0.01.

Table 2
Baseline anthropometric characteristics and skin autofluorescence levels of the fasting and control groups

Variables	Group	(Mean ± S.D.)		
		T0	p-value	Effect size
Weight (kg)	FG	70.22 ± 20.94	0.987	0.000
	CG	70.13 ± 20.22		
BMI (kg/m²)	FG	24.87 ± 6.05	0.971	0.000
	CG	24.82 ± 5.64		
BFP%	FG	25.22 ± 10.06	0.550	0.006
	CG	23.70 ± 9.19		
Muscle mass (kg)	FG	48.76 ± 11.83	0.365	0.015
	CG	45.77 ± 13.02		
TBW%	FG	52.38 ± 6.44	0.546	0.007
	CG	53.39 ± 6.13		
WHtR	FG	0.50 ± 0.08	0.536	0.007
	CG	0.52 ± 0.09		
WHR	FG	0.81 ± 0.09	0.392	0.013
	CG	0.83 ± 0.09		
SAF (AU)	FG	1.59 ± 0.27	0.931	0.000
	CG	1.60 ± 0.33		

Data are presented as mean ± standard deviation. FG: Fasting group; CG: Control group; BMI: Body mass index; BFP: Body fat percentage; TBW: Total body water; WHtR: Waist-to-height ratio; WHR: Waist-to-hip ratio; SAF: Skin autofluorescence; AU: Arbitrary units; ES: Effect size. Cohen's d was used for effect size analysis. *$p \leq 0.05$; **$p < 0.01$.

Table 3
Longitudinal changes in anthropometric parameters and SAF levels in the fasting and control groups

Variables	Group	(Mean ± S.D.)			p-value (ES)		
		T0	T15	T30	Time	Group	Group×Time
Weight (kg)	FG	70.22 ± 20.94	69.51 ± 20.96	69.89 ± 20.80	0.998(0.000)	0.903(0.000)	0.993(0.000)
	CG	70.13 ± 20.22	70.33 ± 20.24	70.30 ± 20.32			
BMI (kg/m²)	FG	24.87 ± 6.05	24.59 ± 6.02	24.70 ± 5.99	0.997(0.000)	0.850(0.000)	0.983(0.000)
	CG	24.82 ± 5.64	24.93 ± 5.67	24.92 ± 5.68			
Fat percentage	FG	25.22 ± 10.06	24.71 ± 9.73	25.26 ± 9.91	0.941(0.001)	0.483(0.003)	0.968(0.000)
	CG	23.70 ± 9.19	23.93 ± 9.15	24.55 ± 8.52			
Muscle mass	FG	48.76 ± 11.83	46.55 ± 10.30	48.88 ± 11.36	0.671(0.005)	0.659(0.001)	0.704(0.004)
	CG	45.77 ± 13.02	47.20 ± 14.12	48.73 ± 12.71			
Total body water (%)	FG	52.38 ± 6.44	53.04 ± 6.26	52.79 ± 5.71	0.810(0.003)	0.947(0.000)	0.719(0.004)
	CG	53.39 ± 6.13	53.11 ± 5.81	51.91 ± 6.96			
WHR	FG	0.81 ± 0.09	0.79 ± 0.09	0.82 ± 0.13	0.683(0.005)	0.336(0.006)	0.764(0.003)
	CG	0.83 ± 0.09	0.82 ± 0.11	0.82 ± 0.11			
WHtR	FG	0.50 ± 0.08	0.49 ± 0.08	0.50 ± 0.08	0.871(0.002)	0.430(0.004)	0.938(0.001)
	CG	0.52 ± 0.09	0.51 ± 0.10	0.51 ± 0.10			
SAF (AU)	FG	1.59 ± 0.27	1.52 ± 0.24	1.53 ± 0.24	0.933(0.001)	0.112(0.015)	0.592(0.006)
	CG	1.60 ± 0.33	1.63 ± 0.35	1.64 ± 0.36			

Data are presented as mean ± standard deviation FG: Fasting group; CG: Control group; BMI: Body mass index; TBW: Total body water; WHtR: Waist-to-height ratio; WHR: Waist-to-hip ratio; SAF: Skin autofluorescence; AU: Arbitrary units; ES: Effect size. Cohen's d was used for between-group effect size analysis, whereas partial η^2 was used for repeated-measures and interaction effects. *$p \leq 0.05$; **$p < 0.01$.

Discussion

In our study, although slight numerical decreases were observed in some anthropometric parameters such as body weight, BMI, body fat percentage, and waist-to-height ratio during the Ramadan fasting period in the FG, no statistically significant effects were detected for time, group, or group × time interaction. In addition, the very small effect sizes indicate that the observed changes were not clinically meaningful. In particular, the reduction in body weight and BMI observed during the second week of Ramadan returned to values close to baseline after Ramadan, suggesting that these changes were transient and reversible.

Studies investigating the effects of Ramadan fasting on anthropometric measures have reported inconsistent findings. Some studies have demonstrated significant reductions in body weight, BMI, waist circumference, hip circumference, and fat mass during Ramadan [13, 14]. Similarly, Fernando et al. [15] reported transient decreases in body weight and fat mass during Ramadan fasting; however, these effects largely disappeared in the weeks following Ramadan. In contrast, some studies have reported no significant effects of Ramadan fasting on anthropometric parameters. Al-Barha and Aljaloud [16] found no significant changes in body composition parameters before, during, and after Ramadan in healthy male participants.

These discrepancies across studies are thought to be attributable to differences in sample characteristics, age groups, baseline BMI levels, physical activity status, dietary habits, and timing of measurements. In particular, the inclusion of young and generally healthy individuals in our study sample may have contributed to the limited magnitude of anthropometric changes. Moreover, inter-individual variability in energy intake during Ramadan and the rapid return to habitual dietary patterns after Ramadan may further explain the transient nature of the observed changes.

In our study, although a slight decreasing trend in SAF levels was observed among individuals fasting during Ramadan, this change was not statistically significant. To the best of our knowledge, no study has directly evaluated the effects of Ramadan fasting on SAF levels. Therefore, our findings were interpreted in the context of the biological characteristics of SAF and the potential mechanisms through which Ramadan fasting may influence AGE formation.

SAF is considered a non-invasive marker of AGEs accumulated over long-lived proteins such as collagen, which exhibit relatively slow turnover kinetics over months to years. Therefore, SAF is thought to reflect cumulative long-term glycemic and oxidative burden rather than short-term metabolic fluctuations. Accordingly, the absence of a significant change in SAF levels following approximately one month of

Ramadan fasting may be considered biologically plausible. In addition, the relatively young and metabolically healthy characteristics of the study population may have resulted in lower baseline AGE accumulation, thereby reducing the sensitivity to detect subtle short-term alterations in tissue AGE deposition. However, AGE formation is closely associated with oxidative stress and inflammatory processes. It has also been suggested that SAF may partially reflect not only long-term AGE accumulation but also shorter-term changes in dermal interstitial fluid and the microvascular compartment [12]. Therefore, evidence regarding the effects of Ramadan fasting on oxidative stress and inflammation may contribute to the interpretation of our findings.

Previous studies investigating the metabolic effects of Ramadan fasting have reported improvements in oxidative stress, inflammatory status, and glycation-related biomarkers. Faris et al. [11] demonstrated reductions in TNF-α and IL-6 levels, whereas Al Zunaidy et al. [17] reported improvements in antioxidant defense mechanisms. Similarly, Al-Amri et al. [18] observed decreases in biomarkers associated with protein glycation. However, these biomarkers primarily reflect short-term metabolic and inflammatory alterations, whereas SAF is considered a marker of cumulative long-term tissue AGE deposition. Therefore, the discrepancy between improvements in circulating metabolic markers and the absence of measurable SAF alterations in the present study may reflect differences in the biological time scale captured by these assessment methods.

The lack of significant changes in SAF levels in our study may be explained by the possibility that the beneficial effects of Ramadan fasting on oxidative stress and glycation processes were not sufficient to induce measurable changes in tissue AGE accumulation. Furthermore, the relatively young age and metabolically healthy status of the participants may have contributed to a lower baseline AGE burden, thereby limiting the detectability of potential changes.

This study has several limitations. First, the study population consisted mainly of young and healthy university students, which may limit the generalizability of the findings to other populations. In addition, dietary intake, dietary AGE exposure, and physical activity levels were not objectively monitored throughout Ramadan. Since exogenous AGE intake is considered an important contributor to systemic AGE burden, the absence of detailed nutritional assessment may have influenced the interpretation of SAF changes. Furthermore, the relatively short duration of Ramadan fasting may not have been sufficient to induce measurable alterations in long-term AGE accumulation assessed by SAF.

Conclusions

In conclusion, Ramadan fasting did not produce statistically significant changes in anthropometric parameters or SAF levels in this population of young and generally healthy adults. Although slight reductions in SAF and some body composition parameters were observed during the fasting period, these changes were transient and not clinically meaningful. Considering that SAF reflects long-term AGE accumulation, the absence of significant alterations following a relatively short fasting period may be biologically expected. Further longitudinal studies involving larger and metabolically diverse populations,

particularly individuals with elevated baseline metabolic or oxidative stress burden, are needed to better clarify the potential effects of Ramadan fasting on AGE accumulation and cardiovascular risk. Future studies incorporating detailed dietary assessment and biochemical glycation markers may provide a more comprehensive understanding of the relationship between Ramadan fasting and AGE metabolism.

Declarations

Author contributions

Conceptualization: Burak Erim, Yaren Aray, Halil İbrahim Binici; Methodology: Burak Erim, Yaren Aray, Halil İbrahim Binici, Ayşenur Taşlı; Formal analysis: Burak Erim, Yaren Aray; Investigation/Data collection: Burak Erim, Yaren Aray, Ayşenur Taşlı; Data curation: Burak Erim, Yaren Aray, Halil İbrahim Binici, Ayşenur Taşlı; Writing-original draft: Burak Erim, Yaren Aray; Writing review & editing: Burak Erim, Yaren Aray, Halil İbrahim Binici, Ayşenur Taşlı; Supervision: Burak Erim. All authors read and approved the final manuscript.

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Data Availability

No additional datasets were generated or analyzed beyond those reported in the manuscript.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and received ethical approval from the Istanbul Esenyurt University Ethics Committee (Approval No: 2025/02; Decision No: 26). Written informed consent was obtained from all participants prior to data collection.

References

1. Yamagishi, S. I. (2012). Potential clinical utility of advanced glycation end product cross-link breakers in age- and diabetes-associated disorders. Rejuvenation Research, 15(6), 564–572. https://doi.org/10.1089/rej.2012.1335
2. Cooke, J. (2017). Dietary reduction of advanced glycation end products: An opportunity for improved nutrition care. Journal of Renal Nutrition, 27(4), e23–e26. https://doi.org/10.1053/j.jrn.2017.04.003

3. Erim, B., & Binici, H. İ. (2024). Advanced glycation end products: Understanding their health risks and effective prevention strategies. Nutrire, 49, 54. https://doi.org/10.1186/s41110-024-00298-z
4. Vlassara, H., & Uribarri, J. (2014). Advanced glycation end products (AGE) and diabetes: Cause, effect, or both? Current Diabetes Reports, 14(1), Article 453. https://doi.org/10.1007/s11892-013-0453-1
5. Poulsen, M. W., Hedegaard, R. V., Andersen, J. M., de Courten, B., Bügel, S., Nielsen, J., Skibsted, L. H., & Dragsted, L. O. (2013). Advanced glycation endproducts in food and their effects on health. Food and Chemical Toxicology, 60, 10–37. https://doi.org/10.1016/j.fct.2013.06.052
6. Monnier, V. M., Vishwanath, V., Frank, K. E., Elmets, C. A., Dauchot, P., & Kohn, R. R. (1986). Relation between complications of type I diabetes mellitus and collagen-linked fluorescence. The New England Journal of Medicine, 314(7), 403–408. https://doi.org/10.1056/NEJM198602133140702
7. Obayashi, H., Nakano, K., Shigeta, H., Yamaguchi, M., Yoshimori, K., Fukui, M., Fujii, M., Kitagawa, Y., Nakamura, N., Nakamura, K., Nakazawa, Y., Ienaga, K., Ohta, M., Nishimura, M., Fukui, I., & Kondo, M. (1996). Formation of crossline as a fluorescent advanced glycation end product in vitro and in vivo. Biochemical and Biophysical Research Communications, 226(1), 37–41. https://doi.org/10.1006/bbrc.1996.1308
8. Meerwaldt, R., Graaff, R., Oomen, P. H. N., Links, T. P., Jager, J. J., Alderson, N. L., Thorpe, S. R., Baynes, J. W., Gans, R. O. B., & Smit, A. J. (2004). Simple non-invasive assessment of advanced glycation endproduct accumulation. Diabetologia, 47(7), 1324–1330. https://doi.org/10.1007/s00125-004-1451-2
9. Ajabnoor, G. M., Bahijri, S., Borai, A., Abdulkhaliq, A. A., Al-Aama, J. Y., & Chrousos, G. P. (2014). Health impact of fasting in Saudi Arabia during Ramadan: Association with disturbed circadian rhythm and metabolic and sleeping patterns. PLoS ONE, 9(5), e96500. https://doi.org/10.1371/journal.pone.0096500
10. Lessan, N., & Ali, T. (2019). Energy metabolism and intermittent fasting: The Ramadan perspective. Nutrients, 11(5), Article 1192. https://doi.org/10.3390/nu11051192
11. Faris, M. A.-I. E., Jahrami, H. A., Obaideen, A. A., & Madkour, M. I. (2019). Impact of diurnal intermittent fasting during Ramadan on inflammatory and oxidative stress markers in healthy people: Systematic review and meta-analysis. Journal of Nutrition & Intermediary Metabolism, 15, 18–26. https://doi.org/10.1016/j.jnim.2018.11.005
12. Atzeni, I. M., van de Zande, S. C., Westra, J., Zwerver, J., Smit, A. J., & Mulder, D. J. (2022). The AGE Reader: A non-invasive method to assess long-term tissue damage. Methods, 203, 533–541. https://doi.org/10.1016/j.ymeth.2021.02.016
13. Al-Jafar, R., Wahyuni, N. S., Belhaj, K., Ersi, M. H., Boroghani, Z., Alreshidi, A., Alkhalaf, Z., Elliott, P., Tsilidis, K. K., & Dehghan, A. (2023). The impact of Ramadan intermittent fasting on anthropometric measurements and body composition: Evidence from LORANS study and a meta-analysis. Frontiers in Nutrition, 10, 1082217. https://doi.org/10.3389/fnut.2023.1082217

14. Farag, H. A. M., Baqi, H. R., Qadir, S. A., El Bilbeisi, A. H., Hamafarj, K. K., Taleb, M., & El Afifi, A. (2020). Effects of Ramadan fasting on anthropometric measures, blood pressure, and lipid profile among hypertensive patients in the Kurdistan region of Iraq. SAGE Open Medicine, 8, 2050312120965780. https://doi.org/10.1177/2050312120965780
15. Fernando, H. A., Zibellini, J., Harris, R. A., Seimon, R. V., & Sainsbury, A. (2019). Effect of Ramadan fasting on weight and body composition in healthy non-athlete adults: A systematic review and meta-analysis. Nutrients, 11(2), 478. https://doi.org/10.3390/nu11020478
16. Al-Barha, N. S., & Aljaloud, K. S. (2018). The effect of Ramadan fasting on body composition and metabolic syndrome in apparently healthy men. American Journal of Men's Health, 13(1), 1–8. https://doi.org/10.1177/1557988318816925
17. Al Zunaidy, N. A., Al-Khalifa, A. S., Alhussain, M. H., Althwab, S. A., Mohammed, M. A., & Faris, M. A. E. (2024). The effect of Ramadan intermittent fasting on anthropometric, hormonal, metabolic, inflammatory, and oxidative stress markers in pre- and post-menopausal women: A prospective cohort of Saudi women. Frontiers in Nutrition, 11, 1437169. https://doi.org/10.3389/fnut.2024.1437169
18. Al-Amri, A. S., Abo-Elmagd, Y. E., Kadi, M. S., Aloufi, F. F., & Bakheit, K. H. (2023). Evaluation of dry fasting effect during Ramadan on protein glycation in Saudi individuals. International Journal of Biochemistry Research & Review, 32(2), 21–31. https://doi.org/10.9734/IJBCRR/2023/v32i2799

Figures

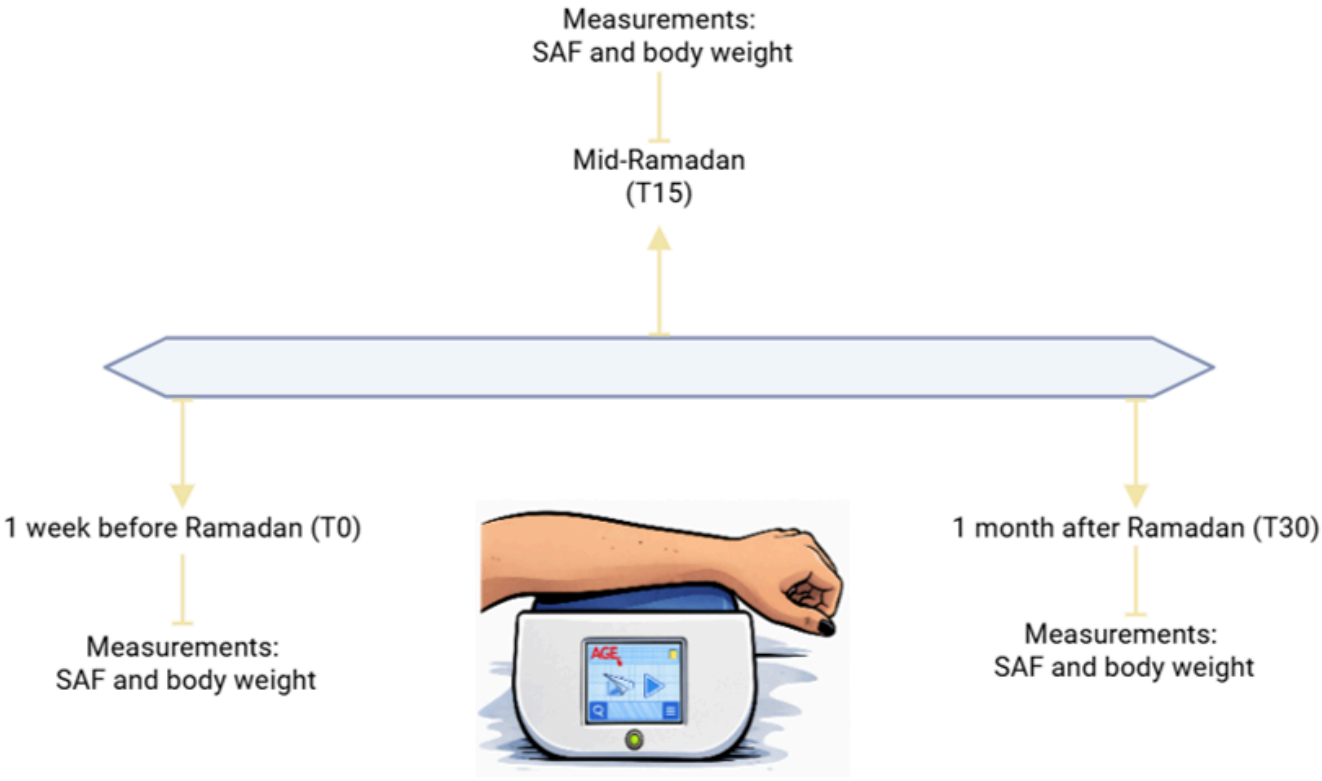


Figure 1

Study design and timeline of anthropometric and skin autofluorescence (SAF) measurements

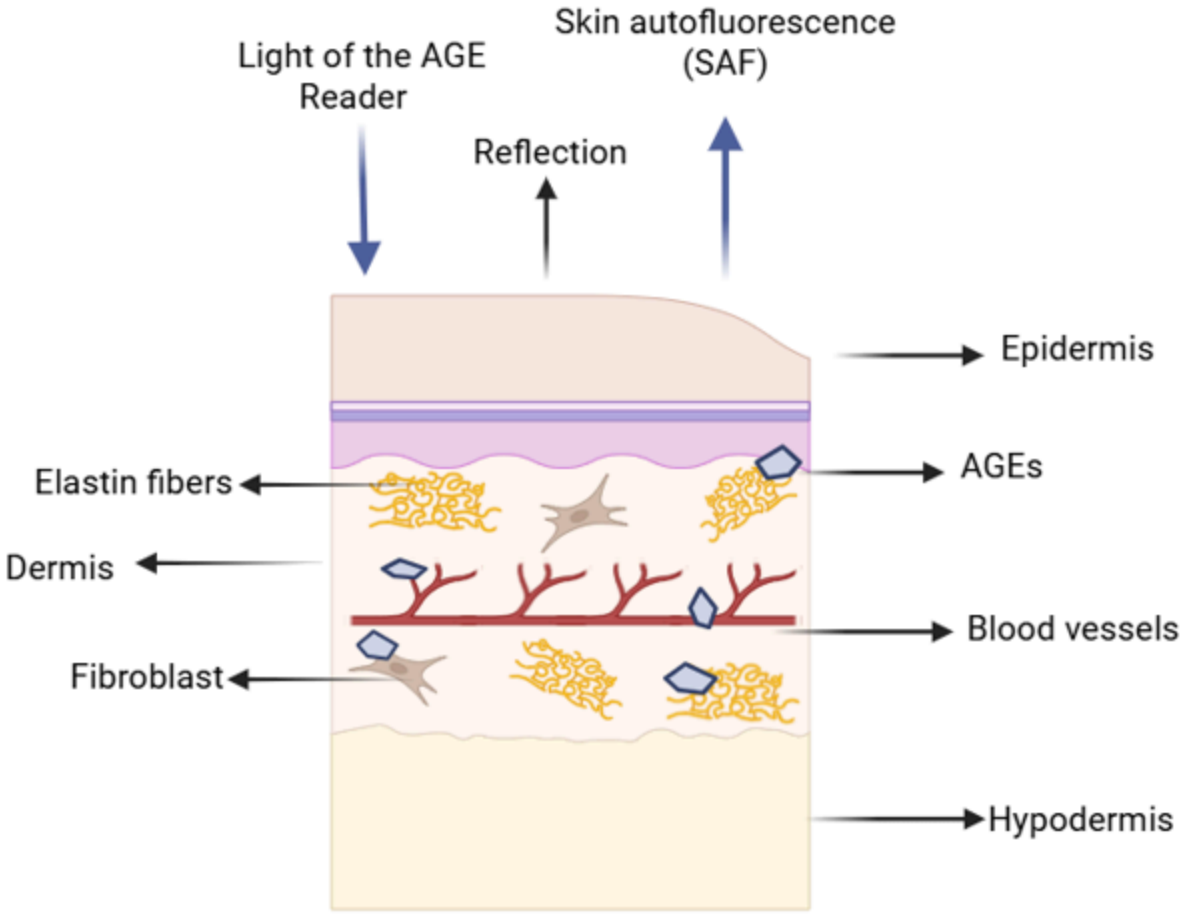


Figure 2

Schematic illustration of SAF measurement and AGE accumulation in skin tissue.