



Level of advanced glycation end products in older adults: association with diet and body composition

Maria Cecília Ferreira¹ 
Camila Santos Lemos¹ 
Júlia Constantino Aun¹ 
Juliana Alves Macedo² 
Gabriela Alves Macedo² 
Alessandra Gambero^{1,2} 

Abstract

Objective: To evaluate dietary intake of advanced glycation end products (AGEs) in older adults and potential correlations with body composition and muscle health. **Methods:** A cross-sectional observational study involving individuals aged 60 and older (n=72) was conducted. Data collection included application of a food frequency questionnaire for AGE-rich foods (FFQ-AGE). Skin autofluorescence (SAF) was measured as a marker of AGE accumulation. Body composition was assessed using body mass index (BMI), bioimpedance, and calf circumference, while sarcopenia risk was evaluated using handgrip strength, Timed Up and Go (TUG) Test, and SARC-F score. **Results:** The average dietary AGE intake was $12,104 \pm 5,719$ kU/day, with no significant differences by sex or marital status. No correlation was found between dietary AGE intake and SAF, BMI, or physical performance. However, SAF positively correlated with BMI, fat mass, and sarcopenic obesity index, indicating an association with unfavorable body composition. Only 2.8% of participants were sarcopenic according to SARC-F, although 20.8% had low handgrip strength and 37.5% had impaired mobility on the TUG test. **Conclusion:** Although dietary AGE intake did not correlate with AGE accumulation or physical performance, SAF was associated with obesity-related measures. These findings suggest that AGE accumulation in older adults may be more influenced by body composition or endogenous production than dietary intake. Monitoring SAF could be useful for assessing cardiovascular risk and health outcomes in aging populations.

Keywords: Advanced Glycation end Products. Obesity. Older Adults. Diet.

¹ Pontifícia Universidade Católica de Campinas (PUC-Campinas), Escola de Ciências da Vida. Campinas, SP, Brasil.

² Universidade Estadual de Campinas, Departamento de Alimentos e Nutrição, Faculdade de Engenharia de Alimentos. Campinas, SP, Brasil.

Funding: Gambero, A. is a scholarship recipient of Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq 302733/2022-1).

The authors declare that there is no conflict in the conception of this work.

Correspondence
Alessandra Gambero
alessandra.gambero@puc-campinas.edu.br

Received: October 28, 2025
Approved: February 5, 2026

INTRODUCTION

The term "glycation products" refers to numerous compounds with different structures that form from the Maillard reaction, a chemical reaction between reducing carbohydrates and amino compounds during food processing and cooking. Initially, reducing sugars such as glucose and fructose react with the ϵ -amino group of lysine, which is most abundant in foods, a reaction known as "glycation" of lysine. Subsequently, these products undergo Amadori rearrangements, forming Amadori rearrangement products (ARPs) such as fructosyllysine (FL) from glucose, and also Heyns rearrangement products (HRPs) such as glucosyl- and mannosyllysine from fructose. Because they are unstable, ARPs undergo degradation reactions during food processing and preparation, forming 1,2-dicarbonyl compounds such as glyoxal (GO), methylglyoxal (MGO), and 3-deoxyglucosone (3-DG), which are highly reactive. Advanced glycation end products (AGEs) exert harmful effects because they activate receptors for advanced glycation end products (RAGEs) present in different cells or bind to biomolecules, leading to loss of their function¹.

RAGE is a cell surface receptor of the immunoglobulin superfamily. The binding of AGEs to RAGE triggers a series of downstream signaling events, such as activation of nuclear factor kappa B (NF- κ B), which in turn promotes production of inflammatory cytokines such as tumor necrosis factor alpha (TNF- α), interleukin-6 (IL-6), and interleukin-1 β (IL-1 β), creating a pro-inflammatory environment characteristic of pathological aging². Glycation of enzymes and insulin receptors contributes to insulin resistance and mitochondrial dysfunction, reducing efficiency in energy production. Lastly, AGEs create cross-links in collagen fibers and contractile muscle proteins, making these more rigid and less functional, accelerating loss of strength and muscle mass. Thus, an increase in expression of RAGEs and AGEs is observed in conditions such as type 2 diabetes mellitus (DM), cardiovascular disorders, sarcopenia and frailty in chronic kidney disease, cancer, and Alzheimer's disease³.

Given the role of AGEs in diseases associated with aging, research suggests that dietary patterns, such as diets rich in ultra-processed foods, meats grilled at high temperatures, fried foods, and low-moisture foods that have high concentrations of pre-formed AGEs, besides diets with high glycemic index that increase postprandial glycemia and accelerate glycation of endogenous proteins (such as hemoglobin and collagen), increasing the internal load of AGEs independently of direct intake, may act as a direct modulator of the biochemistry of aging⁴.

However, studies exploring the potential association between AGE-rich diets and health outcomes are hampered by a lack of quantitative information and insufficient structural characterization of AGEs in foods. The traditional Brazilian diet is vegetable-based, with rice, beans, and small amounts of meat. However, this pattern has been changing rapidly, with inclusion of breads, oils, fats, soft drinks, pizzas, and snacks. Older adults living alone eat increasingly less traditional Brazilian food and may be exposed to an AGE-rich diet⁵, promoting the development of age-associated diseases.

The objective of this study was to evaluate dietary intake of AGEs and their accumulation among older adults seen under a university program, and to investigate potential associations with body composition and muscle health.

METHODS

A cross-sectional observational study was conducted involving 72 participants from the Vitalità Center for Aging and Longevity at PUC-Campinas aged ≥ 60 years, who consented to take part in the investigation. The study was approved by the Institutional Research Ethics Committee (CEP – PUC - CAAE: 75683723.2.00005481; Report Number: 6.529.820). Data collection was carried out between March and December 2024 and met the requirements of Resolution No. 466/2012.

Basic sociodemographic information collected included age, sex, educational level, and marital

status. Medications being used were recorded and participants were asked to self-declare their skin phototype using the Fitzpatrick scale. A semi-quantitative self-administered questionnaire of 67 food items containing AGE-rich foods (FFQ-AGE) was completed by participants. The FFQ-AGE was created based on the AGE-rich food table devised by Uribarri et al.⁶ and adapted for the Brazilian diet, substituting foods of similar composition in terms of amount of AGE, drawing on the Food Frequency Questionnaire used in the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)⁷. Food portions were expressed in household measures (tablespoon, cup) or traditional food portions (piece, unit). Participants reported the number of times and frequency with which they consumed a food (more than 3x/day, 2-3x/day, 1x/day, 5-6x/week, 2-4x/week, 1x/week, 1-3x/month, never/rarely) and reported seasonal consumption. Level of AGE intake was calculated by multiplying the amount of AGE per food portion by the frequency of consumption.

The mean of three consecutive skin autofluorescence (SAF) measurements on participants' right forearms was obtained using the Diagnostics® AGE Reader device. The AGE Reader also calculates cardiovascular risk by stratifying the SAF value by participant age, giving a score of 1 to 4, indicating low, mild, moderate, and high cardiovascular risk, respectively.

Body composition was analyzed by calculating body mass index (BMI; kg/m²) from weight and height data obtained using a mechanical medical scale. Obesity was defined as a BMI ≥ 32 kg/m² for older female individuals and ≥ 28 kg/m² for older male individuals. The amount of fat mass was estimated by electrical bioimpedance (Biodynamics, 310e, TBW). The cut-off values for percentage fat mass indicating obesity was $\geq 35\%$ for women and $\geq 24\%$ for men. Calf circumference was measured for the dominant leg using a non-elastic tape in the standing position, at the maximum circumference in the plane perpendicular to the longitudinal line of the calf. Calf circumference ≤ 34 cm for men and ≤ 33 cm for women can be considered a surrogate marker of low muscle mass. Sarcopenic obesity was calculated using the ratio of the diagnostic variables for obesity

(fat mass) and sarcopenia (calf circumference). Handgrip strength (kg) was evaluated using a digital dynamometer (Instrutherm, DM-90). The cut-off value indicating low muscle strength was ≤ 27 kg for men and ≤ 16 kg for women. Functional capacity was evaluated using the Timed Up and Go test (TUG test)⁸. The time taken to rise from the chair, walk 3 meters, and sit back down again on the chair was timed by the observer with the aid of a stopwatch. For the TUG test, a time of ≤ 10 s was considered normal, whereas ≥ 11 s was defined as frailty with greater risk of impaired mobility. Participants answered the SARC-F questionnaire, which evaluates strength, mobility, and falls in the last year. Each item has three severity levels, with scores ranging from zero to two points. A SARC-F score ≥ 4 out of 10 is recommended in International Guidelines as the value to identify individuals at risk of sarcopenia⁹.

Anthropometric data, bioimpedance, handgrip strength, and the TUG test were performed by the same researcher. The weighing scales, handgrip, and bioimpedance equipment were duly calibrated by their manufacturers or representatives before study initiation.

Exploratory data analysis was performed by calculating descriptive statistics (mean, confidence interval, and percentage). Bivariate correlation analyses were performed using Spearman or Pearson Correlation Coefficients, for non-parametric or parametric variables, respectively. Multivariate linear regression analysis was performed on variables with $p < 0.20$ in the bivariate analysis. P-values < 0.05 were considered significant.

DATA AVAILABILITY

The full anonymized data set underpinning the study results is available from **FIGSHARE** at <https://figshare.com/s/8b6b1b2b7f1b5384100e>.

RESULTS

Of the 72 participants, the majority declared gender as female and had completed higher education.

Regarding marital status, half of the sample reported living with a partner and half lived alone. Participant age ranged from 60 to 81 years. Roughly one-third of the sample took no medications routinely for chronic diseases (Table 1). Among participants using medications, the main groups reported included statins (15.7%), angiotensin blockers (13.1%), and metformin (11.8%).

Male and female weight and height differed, but BMI was the same across genders. However, in terms of percentage fat mass, calculated by electrical bioimpedance, more women had a body composition characterized as obese than men (Table 2). There was no gender difference for calf circumference or skin autofluorescence. Skin autofluorescence could not be determined for 6 participants (3 women and 3 men) who self-reported a skin phototype of 5-6 on the Fitzpatrick scale. No gender difference was evident

for performance on the TUG test. As expected, handgrip test performance was significantly higher among men. Sarcopenic obesity was determined by calculating fat mass divided by calf circumference. The results reveal a higher index in females than males (Table 2).

Applying the cut-off point stated in the Methods section, the sample showed risk of impaired mobility and low muscle strength. Only one man and two women were considered at high risk of sarcopenia on the SARC-F questionnaire. Obesity was also observed, as measured by BMI and by percentage fat mass using electrical bioimpedance, based on the cut-off parameter defined. For the overall sample, obesity was more prevalent when using the percentage fat mass parameter than for BMI. There were no statistically significant gender differences for the scores evaluated (Table 3).

Table 1. Sociodemographic characteristics and number of medications used for chronic conditions by older adults attending the Vitalità Center for Aging and Longevity at PUC-Campinas (N=72). Campinas, São Paulo state, 2024.

Variable	n (%)
Gender	
Female	57 (79.2)
Male	15 (20.8)
Educational level	
No formal study	1 (1.4)
Primary	6 (8.3)
Secondary	25 (34.7)
Higher	34 (47.2)
Post-graduate	6 (8.3)
Marital status	
Single	9 (12.5)
Married	37 (51.4)
Divorced	9 (12.5)
Widowed	17 (23.6)
Medications used routinely	
None	22 (30.6)
1 medication	14 (19.4)
2-4 medications	24 (33.3)
≥5 medications	12 (16.7)

Table 2. Age, body composition, skin autofluorescence, and physical performance of older adults attending the Vitalità Center for Aging and Longevity at PUC-Campinas (N=72). Campinas, São Paulo state, 2024.

Variable	Total mean (Confidence interval*)	Male mean (Confidence interval*)	Female mean (Confidence interval*)	Correlation coefficient	<i>p</i> #
Age (years)	68.1 (66.7-69.4)	70.9 (68.4-73.4)	67.3 (65.8-68.9)	0.273	0.020
Body weight (Kg)	72.4 (69.5-75.3)	79.4 (73.5-85.3)	70.6 (67.4-73.8)	0.292	0.013
Height (m)	1.63 (1.6-1.65)	1.73 (1.69-1.78)	1.59 (1.58-1.62)	0.575	0.0001
Body Mass Index (BMI)	27.3 (26.3-28.2)	26.3 (24.7-27.9)	27.5 (26.4-28.7)	-0.110	0.35
Fat mass (%)	32.3 (30.6-34.1)	22.8 (19.8-25.9)	34.7 (33.17-36.23)	-0.578	0.0001
Fat mass (kg)	23.4 (21.6-25.2)	17.9 (15.1-20.7)	24.8 (22.9-26.8)	-0.376	0.001
Calf circumference (cm)	37.5 (36.9-38.0)	37.9 (37.0-38.8)	37.4 (36.8-38.0)	0.123	0.305
Skin autofluorescence (A.U.)	2.64 (2.52-2.75)	2.8 (2.5-3.0)	2.6 (2.5-2.7)	0.107	0.390
Skin phototype (Fitzpatrick scale)	2.7 (2.4-3.0)	3.5 (2.8-4.2)	2.6 (2.2-2.9)	0.268	0.022
TUG test (seconds)	10.3 (9.8-10.8)	10.6 (9.1-12.1)	10.2 (9.7-10.7)	-0.044	0.710
Handgrip strength (kg)	26.7 (23.4-30.0)	38.3 (29.4-47.2)	23.7 (20.7-26.7)	0.442	0.0001
Sarcopenic obesity (fat mass/calf circumference)	0.62 (0.58-0.67)	0.47 (0.40-0.55)	0.66 (0.61-0.71)	-0.409	0.0004

TUG test = Timed Up and Go test. *95% confidence interval. # *p*-value for Spearman correlation coefficient.

Table 3. Physical performance scores and body composition of older adults attending the Vitalità Center for Aging and Longevity at PUC-Campinas (N=72). Campinas, São Paulo state, 2024.

	Total n (%)	Male n (%)	Female n (%)	Correlation coefficient	* <i>p</i>
TUG test				-0,114	0,336
Normal	45 (62.5)	11 (73.3)	34 (60.0)		
Higher risk of impaired mobility	27 (37.5)	4 (26.7)	23 (40.0)		
Handgrip strength				-0.179	0.132
Normal	57 (79.2)	14 (93.3)	43 (75.0)		
Low muscle strength	15 (20.8)	1 (6.7)	13 (25.0)		
SARC-F				0.064	0.592
Healthy	69 (96.0)	14 (93.3)	55 (96.0)		
Sarcopenia	3 (4.0)	1 (6.7)	2 (4.0)		
Calf circumference					
Normal	72 (100)				
BMI				-0.180	0.130
Normal	58 (80.6)	10 (66.7)	48 (84.2)		
Obese	14 (19.4)	5 (33.3)	9 (15.8)		
Fat Mass				0.185	0.119
Normal	35 (48.6)	10 (66.7)	25 (43.9)		
Obese	37 (51.4)	5 (33.3)	32 (56.1)		

TUG test = Timed Up and Go test. SARC-F. BMI = body mass index. **p*-value for Spearman correlation coefficient.

The FFQ-AGE revealed that, overall, average dietary AGE intake was $12,104 \pm 5,719$ kU/day. For AGE consumption by gender, men consumed $12,317 \pm 5,554$ kU/day, while women consumed $11,695 \pm 6,499$ kU/day. Regarding marital status, men living alone consumed $13,590 \pm 6,007$ kU/day ($n=10$) and married women $11,898 \pm 5,763$ kU/day ($n=36$), with no significant difference by marital status. The foods frequently consumed that contributed to level of dietary AGE intake were fast food hamburgers and French fries, pizza with baked crust, avocado, nuts in general, butter, and margarine. There was no correlation

between SAF measurements and participant age, calf circumference or physical performance (TUG test and handgrip strength performance), dietary AGE intake, or number of medications taken routinely. However, a positive correlation was found between BMI, fat mass, and sarcopenic obesity on bivariate correlation analysis (Table 4). Skin autofluorescence reader scores indicating higher cardiovascular risk (Mean = 2.42; CI = 2.11-2.73) correlated positively with BMI ($p=0.0022$) and fat mass ($p=0.0027$). In the multivariate model ($R^2=0.9732$), only BMI remained an independent predictor of SAF values (Table 5).

Table 4. Correlation coefficients between skin autofluorescence (SAF) and anthropometric, dietary, and clinical variables in older adults attending the Vitalità Center for Aging and Longevity at PUC-Campinas (N=72). Campinas, São Paulo state, 2024.

Variable	SAF	*p
Age	-0.05	0.6884
BMI	0.44	0.0002
Fat Mass	0.39	0.0010
Calf circumference	0.12	0.3293
TUG test	-0.05	0.6540
Handgrip strength	0.21	0.0776
Sarcopenic obesity	0.38	0.0014
Dietary AGE	0.03	0.7740
Number of medications	-0.09	0.4421

TUG test = Timed Up and Go test. SARC-F. BMI = body mass index. Dietary AGE = dietary advanced glycation end products. *p-value for Spearman correlation coefficient.

Table 5. Multivariate analysis between skin autofluorescence (SAF) and anthropometric and strength variables in older adults attending the Vitalità Center for Aging and Longevity at PUC-Campinas (N=72). Campinas, São Paulo state, 2024.

Variables	β	Confidence Interval	*p
BMI	0.089	0.0565 - 0.1216	<0.0001
Fat mass	0.020	-0.0083 - 0.0487	0.1616
Handgrip strength	0.006	-0.0031 - 0.0152	0.1946
Sarcopenic obesity	-1.029	-2.210 - 0.1515	0.0864

BMI = body mass index. *p-value for multiple linear regression analysis (Least Squares).

DISCUSSION

Studies in the literature have reported an association of accumulation of AGEs in skeletal muscle with reduced muscle regeneration and structural alterations in the extracellular matrix of skeletal muscle. In a cross-sectional study involving 2,744 European participants with a mean age of 74.1 years, cutaneous AGE levels, measured using skin autofluorescence, were high and associated with a higher prevalence of sarcopenia¹⁰.

Thus, one of the main questions of this study was whether AGE accumulation is associated with changes in body composition, such as the presence of sarcopenia or obesity during aging, thereby predisposing individuals to reduced quality of life and the development of chronic diseases. A non-invasive method for detecting and quantifying the accumulation of fluorescent AGEs in tissues is by reading skin autofluorescence (SAF) using ultraviolet (UV) technology. SAF has been increasingly used as a surrogate for more complex methodologies and has been validated against measurements of collagen-bound fluorescent AGEs such as pentosidine, low-molecular-mass cross-links (LMC), and N ϵ -carboxyethyl-lysine (CEL), for example, in patients with diabetes mellitus¹¹. The challenges of employing SAF in an older population with a wide range of skin phototypes (1 to 6 on the Fitzpatrick scale) and the lack of established reference values were also encountered in the present study. The results revealed no correlation between skin autofluorescence and calf circumference, TUG test score, or handgrip strength in the sample assessed, suggesting that AGE accumulation was not associated with physical performance or muscle health of participants. Age was also found not to correlate with skin autofluorescence, and there was no correlation between SAF values and different skin phototypes.

A study of people with type 1 diabetes and healthy young adults (mean age 31 years) showed that skin autofluorescence values increased with age and that the values in individuals with diabetes were only reached later in life by healthy individuals. The authors reported an increase in SAF of 0.029 ± 0.003 arbitrary

units (AU) per year in diabetic individuals versus 0.022 ± 0.002 AU per year in healthy individuals, who had SAF values of 1.66 ± 0.02 AU and 1.48 ± 0.03 AU, respectively¹². Notably, by comparison, the mean SAF value (2.5 ± 0.5) detected in the present study population (mean age 68.1 years) was higher. However, in a more recent study of a Brazilian population with type 2 diabetes with and without chronic kidney disease (mean age of 58 ± 7 years), SAF values were 3 ± 0.8 AU and 2.5 ± 0.7 AU, respectively¹³.

In another study including healthy individuals and participants with chronic diseases such as diabetes, chronic kidney disease, or cardiovascular disease SAF values were 1.90 ± 0.42 and 2.27 ± 0.51 , respectively. The mean ages of the healthy and chronically ill groups were 43.58 ± 11.77 and 55.51 ± 12.07 years, respectively¹⁴. These findings suggest that the older population assessed in the current investigation had higher SAF values due to age and the presence of both healthy and chronic conditions, given that only 30.6% of participants did not routinely take medications. In addition, a Spanish study recently proposed reference SAF values for individuals ≥ 60 years of 2.28 ± 0.56 ¹⁵, suggesting that Brazilian older adults may have relatively higher SAF values.

The present results showed that SAF values, as a proxy of AGE accumulation, were positively correlated with BMI, percentage fat mass, and sarcopenic obesity on the bivariate analysis. Cardiovascular risk, as calculated by the SAF reader, also correlated positively with BMI and fat mass. Multivariate analysis confirmed BMI as a predictor of AGE accumulation during aging.

Lifestyle changes, particularly in dietary patterns, are essential for preventing and controlling obesity. Recent studies have shown that consumption of AGE-rich foods may promote obesity and the development of chronic cardiovascular diseases.

A positive association between dietary methylglyoxal (MGO) and body-weight gain was demonstrated in a European cohort study¹⁶. The present cross-sectional study failed to show any correlation between dietary AGE intake and BMI, fat mass, or muscle performance score in the older adults assessed. No correlation was found between

skin autofluorescence and dietary AGE intake. It is important to note that the dietary assessment tool employed focuses on AGE-rich foods, and that high glycemic-load diets may also favor AGE accumulation in the body. The FFQ applied showed that the participants consumed $12,104 \pm 5,719$ kU/day of dietary AGEs. Although no reference value for AGE intake has been established, some studies report a wide range of 4,000 to 24,000 kU/day, without taking the health status of participants into account¹⁷. The disparity among studies is large because different methods of data collection were used. Uribarri et al., using a three-day food record, reported a baseline intake of $12,400 \pm 1,000$ kU/day in an intervention study involving participants aged over 60 years, with no differences between men and women¹⁸. In another study, AGE intake in middle-aged individuals was $9,754 \pm 3,936$ kU/day versus $9,893 \pm 3,784$ kU/day in older adults, and no correlation was found between dietary intake, body composition, or metabolic parameters using data from 24-hour recalls and an FFQ¹⁹. In a Dutch study, high dietary AGE intake was not associated with physical frailty²⁰.

Limitations of the present study include its cross-sectional design, lack of a control group, and the absence of a detailed clinical assessment of participants' health status. Other limitations were the small sample size, the possibility of recall bias when completing questionnaires, and the fact that the sample does not fully reflect the Brazilian older population, as illustrated below.

According to data published in 2022 by the Brazilian Institute of Geography and Statistics (IBGE), the total number of people aged 60 years or older (32,113,490) corresponded to 15.6% of the national population, representing a 56.0% increase compared to the 2010 census. Of these older adults, 55.7% were women and 44.3% were men. The present sample did not mirror this distribution, suggesting that older women may be more socially active and more likely than men to seek activities offered by university outreach programs. Regarding educational level, 20.7% of women aged 25 years or older had completed higher education versus 15.8% of men. In the age group of 65 years or

older, literacy was 93.5% for women and 92.5% for men²¹. The sample was also not representative of the Brazilian older population with respect to education, suggesting that opportunities to return to university are more accessible to older Brazilians with higher educational level²¹.

The presence of sarcopenia in aging populations is common and poses a major problem, as it dramatically increases the risk of falls, frailty, disability, hospitalization, and mortality among older adults. In 2019, the European Working Group on Sarcopenia in Older People (EWGSOP) updated the original definition of sarcopenia as a muscle disease (muscle failure) in which low muscle strength overtakes low muscle mass as the primary determinant and predictor of adverse outcomes²². A systematic review and meta-analysis including 9,416 participants from 31 studies of Brazilian older adults found that the prevalence of sarcopenia was 16.0% when both low muscle mass and low muscle function were criteria compared with 17.0% when based solely on low muscle mass²³. All participants in the current sample had calf circumferences above the cut-off for low muscle mass, and only 4% had SARC-F scores indicating risk of sarcopenia. However, 20.8% had low performance on the handgrip test, indicating loss of strength, which is considered more important than muscle mass alone. Moreover, 37.5% of participants failed to attain normal performance on the TUG test and therefore had a higher risk of falls. Loss of muscle strength, not attributable to neurological or primary muscular disease, is known as dynapenia, although the distinction between dynapenia and sarcopenia may not be clinically relevant²⁴.

The presence of obesity has a major impact on negative health outcomes. A recent study that sought to determine the optimal BMI range for older adults suggested that an ideal BMI is 31–32 kg/m² for older women and 27–28 kg/m² for older men²⁵. By contrast, another study showed that a BMI ≥ 30 kg/m² was associated with a 60% increased risk of mobility limitations, regardless of lifestyle habits²⁶. If applying these geriatric-specific ranges rather than the cut-offs proposed for younger adults (overweight > 25 kg/m²), 19.4% of the current sample would be classified as obese. Based on a healthy body-fat

percentage for women aged 60–79 years of 24–35% and for men of 13–24%, the fat mass values obtained by bioimpedance for the sample assessed indicate that 48.6% of the participants were obese, underscoring the need for early interventions to prevent obesity in older adults in Brazil.

CONCLUSION

Accumulation of advanced glycation end products, evaluated by skin autofluorescence, was associated with unfavorable body composition, particularly obesity, indicating an increased risk of cardiovascular diseases. A diet rich in advanced glycation end products was not correlated with the observed accumulation of these products, suggesting that increased endogenous production or reduced excretion capacity are the main factors associated with AGE accumulation during aging. New therapeutic strategies need to be developed and may be useful in the future to control AGE accumulation that occurs with aging, especially in obese adults.

REFERENCES

- Hellwig M, Diel P, Eisenbrand G, Grune T, Guth S, Henle T, et al. Dietary glycation compounds - implications for human health. *Crit Rev Toxicol.* 2024;54(8):485-617. <https://doi.org/10.1080/1040844.4.2024.2362985>
- Cross K, Vetter SW, Alam Y, Hasan MZ, Nath AD, Leclerc E. Role of the receptor for advanced glycation end products (RAGE) and its ligands in inflammatory responses. *Biomolecules.* 2024;14(12):1550. <https://doi.org/10.3390/biom14121550>
- Dong H, Zhang Y, Huang Y, Deng H. Pathophysiology of RAGE in inflammatory diseases. *Front Immunol.* 2022;13:931473. <https://doi.org/10.3389/fimmu.2022.931473>
- Avila F, Cruz N, Gonzalez MA, Fuentes E, Wehinger S, Lutz M. Dietary advanced glycation end products (AGEs): A modifiable risk factor in the prevention of chronic diseases associated with aging? *Biochimie.* 2025;235:80-92. <https://doi.org/10.1016/j.biochi.2025.06.001>
- Pinheiro ITR, Muraro AP, Andrade ACS, Ferreira MG, Pereira RA, Rodrigues PRM. Food intake of older adults living alone: Brazilian National Dietary Survey. *Rev Nutr.* 2024;37(e240016):14. <https://doi.org/10.1590/1678-9865202437e240016>
- Uribarri J, Woodruff S, Goodman S, Cai W, Chen X, Pyzik R, et al. Advanced glycation end products in foods and a practical guide to their reduction in the diet. *J Am Diet Assoc.* 2010;110(6):911-6.e12. <https://doi.org/10.1016/j.jada.2010.03.018>
- Molina MC. Diet assessment in the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil): Development of a food frequency questionnaire. *Rev Nutr.* 2013;26(2):167-76. <https://doi.org/10.1590/S1415-52732013000200005>
- Herman T, Giladi N, Hausdorff JM. Properties of the 'timed up and go' test: more than meets the eye. *Gerontology.* 2011;57(3):203-10. <https://doi.org/10.1159/000314963>

AUTHORSHIP

- Maria Cecília Ferreira – Data collection; data analysis and interpretation; approval of the version to be published.
- Camila Santos Lemos – Data collection; approval of the version to be published
- Júlia Constantino Aun – Data collection; approval of the version to be published.
- Juliana Alves Macedo – Project conception; data analysis and interpretation; approval of the version to be published.
- Gabriela Alves Macedo – Project conception; data analysis and interpretation; approval of the version to be published.
- Alessandra Gambero – Project conception; funding acquisition; data analysis and interpretation; manuscript writing

Edited by: Camila Alves dos Santos

9. Waqas K, Chen J, Trajanoska K, Ikram MA, Uitterlinden AG, Rivadeneira F, et al. Skin Autofluorescence, a Noninvasive Biomarker for Advanced Glycation End-products, Is Associated With Sarcopenia. *J Clin Endocrinol Metab.* 2022;107(2):e793-e803. <https://doi.org/10.1210/clinem/dgab632>
10. Okoye C, Morelli V, Franchi R, Mazzarone T, Guarino D, Maccioni L, et al. Usefulness of the SARC-F questionnaire and the measurement of the hand grip strength in predicting short-term mortality in older patients hospitalized for acute heart failure. *Eur Geriatr Med.* 2024;15(6):1839-47. <https://doi.org/10.1007/s41999-024-01054-2>
11. Deng T, Wu J, Cheng H. Skin autofluorescence is associated with blood glucose levels, especially in children with type 1 diabetes. *Front Clin Diabetes Healthc.* 2025;6:1590288. <https://doi.org/10.3389/fcdhc.2025.1590288>
12. Januszewski AS, Xu D, Cho YH, Benitez-Aguirre PZ, O'Neal DN, Craig ME, et al. Skin autofluorescence in people with type 1 diabetes and people without diabetes: An eight-decade cross-sectional study with evidence of accelerated aging and associations with complications. *Diabet Med.* 2021;38(7):e14432. <https://doi.org/10.1111/dme.14432>
13. Barreto J, Martins M, Borges CM, Vitte SH, Nadruz Junior W, Oliveira RB, et al. Skin accumulation of advanced glycation end-products predicts kidney outcomes in type 2 diabetes: results from the Brazilian Diabetes Study. *J Bras Nefrol.* 2024;46(4):e20240047. <https://doi.org/10.1590/2175-8239-JBN-2024-0047en>
14. van de Zande SC, de Vries JK, van den Akker-Scheek I, Zwerver J, Smit AJ. A physically active lifestyle is related to a lower level of skin autofluorescence in a large population with chronic-disease (LifeLines cohort). *J Sport Health Sci.* 2022;11(2):260-5. <https://doi.org/10.1016/j.jshs.2020.09.007>
15. Martinez-Garcia I, Cavero-Redondo I, Pascual-Morena C, Otero-Luis I, Fenoll-Morate M, Lever-Megina CG, et al. Reference Values of Skin Autofluorescence by Age Groups in Healthy Spanish Adults: Results from the EVasCu Study, a Systematic Review, and a Meta-Analysis. *J Clin Med.* 2025;14(2):474. <https://doi.org/10.3390/jcm14020474>
16. Debras C, Cordova R, Mayen AL, Maasen K, Knaze V, Eussen S, et al. Dietary intake of dicarbonyl compounds and changes in body weight over time in a large cohort of European adults. *Br J Nutr.* 2024;131(11):1902-14. <https://doi.org/10.1017/S0007114524000503>
17. Nowotny K, Schroter D, Schreiner M, Grune T. Dietary advanced glycation end products and their relevance for human health. *Ageing Res Rev.* 2018;47:55-66. <https://doi.org/10.1016/j.arr.2018.06.005>
18. Uribarri J, Cai W, Pyzik R, Goodman S, Chen X, Zhu L, et al. Suppression of native defense mechanisms, SIRT1 and PPARgamma, by dietary glycoxidants precedes disease in adult humans; relevance to lifestyle-engendered chronic diseases. *Amino Acids.* 2014;46(2):301-9. <https://doi.org/10.1007/s00726-013-1502-4>
19. Maza MP, Bravo A, Leiva L, Gattas V, Petermann M, Garrido F, et al. Fluorescent serum and urinary advanced glycoxidation end-products in non-diabetic subjects. *Biol Res.* 2007;40(2):203-12. <https://doi.org/10.4067/s0716-97602007000200011>
20. Waqas K, Chen J, Lu T, van der Eerden BCJ, Rivadeneira F, Uitterlinden AG, et al. Dietary advanced glycation end-products (dAGEs) intake and its relation to sarcopenia and frailty - The Rotterdam Study. *Bone.* 2022;165:116564. <https://doi.org/10.1016/j.bone.2022.116564>
21. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo Brasileiro de 2022 [Internet]. Rio de Janeiro: IBGE; 2022 [Accessed on 3 Feb 2026]. Available from: <https://www.ibge.gov.br>.
22. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyere O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing.* 2019;48(1):16-31. <https://doi.org/10.1093/ageing/afy169>
23. Diz JB, Leopoldino AA, Moreira BS, Henschke N, Dias RC, Pereira LS, et al. Prevalence of sarcopenia in older Brazilians: A systematic review and meta-analysis. *Geriatr Gerontol Int.* 2017;17(1):5-16. <https://doi.org/10.1111/ggi.12720>
24. Clark BC, Manini TM. What is dynapenia? *Nutrition.* 2012;28(5):495-503. <https://doi.org/10.1016/j.nut.2011.12.002>
25. Kiskac M, Soysal P, Smith L, Capar E, Zorlu M. What is the Optimal Body Mass Index Range for Older Adults? *Ann Geriatr Med Res.* 2022;26(1):49-57. <https://doi.org/10.4235/agmr.22.0012>
26. Koster A, Patel KV, Visser M, van Eijk JT, Kanaya AM, de Rekeneire N, et al. Joint effects of adiposity and physical activity on incident mobility limitation in older adults. *J Am Geriatr Soc.* 2008;56(4):636-43. <https://doi.org/10.1111/j.1532-5415.2007.01632.x>