

## **Habits, lifestyles and Sociality: a cluster analysis of Italian University Students**

### **Abitudini, stili di vita e socialità: una cluster analysis di studenti universitari italiani**

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**Parole chiave:** AGEs; comportamenti sociali; studenti universitari; stili di vita

#### **Abstract**

The analysis of health determinants in the student population can be useful in raising awareness on safe living conditions in new generations. The selection of specific biomedical markers, like advanced glycation end products (AGEs), and the analysis of social behaviors can support lifestyle choices evaluation.

A questionnaire, containing an anamnestic section, a physical activity evaluation section, and a sociological section, was administered to a total of 110 students from two Italian universities, selected from the Faculty of Science of Movement and from the Faculty of Medicine. In addition, all subjects recruited in this study underwent to an AGEs accumulation assessment through skin autofluorescence.

A non-hierarchical cluster analysis was performed on the collected data allowed the identification of two group of students: group 1 mainly consisted of male subjects from the Faculty of Science of Movement, characterized by an active lifestyle and a rather detached affective family condition; group 2 largely consisted of female subjects from the Faculty of Medicine, more sedentary and with stable relationships.

The data analysis confirmed the correlation between low AGEs levels and healthy lifestyles, but at the same time underlined divergences between students from different Faculties.

## Riassunto

L'analisi dei determinanti della salute nella popolazione studentesca può essere utile ad accrescere la consapevolezza dei corretti stili di vita nelle giovani generazioni. La selezione di specifici marker biomedici, quali gli advanced glycation end products (AGEs), assieme all'analisi dei comportamenti sociali può essere di aiuto nella valutazione delle scelte di stili di vita.

Un questionario, contenente una sezione anamnestica, una di valutazione del grado di attività fisica e una dedicata ai parametri sociologici, è stato sottoposto a 110 studenti di due atenei italiani, selezionandoli tra le Facoltà di Scienze Motorie e la Facoltà di Medicina. Inoltre, gli studenti reclutati per lo studio sono stati sottoposti all'analisi dei livelli di AGEs tramite test dell'autofluorescenza cutanea.

L'analisi dei dati tramite clusterizzazione non gerarchica ha permesso di identificare due gruppi di studenti: il gruppo 1 caratterizzato principalmente da soggetti maschili della Facoltà di Scienze Motorie con stile di vita attivo e rapporti affettivi familiari distaccati; il gruppo 2 prevalentemente composto da soggetti femminili della Facoltà di Medicina con stile di vita maggiormente sedentario e relazioni affettive stabili.

L'analisi dei dati ha confermato la correlazione tra bassi valori di AGEs e stili di vita salutari, ma allo stesso tempo ha sottolineato la presenza di differenze tra studenti di diverse facoltà universitarie.

## Introduction

According to the definition of the World Health Organization (WHO), health is « a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity» (1). To these principles is also added what is stated in the “Ottawa Charter” (document drawn up in 1986 during the International Conference for the Promotion of Health) and in particular that, to achieve a good level of health, the individual and the group must be able to identify and develop their aspirations, satisfy their needs, change the environment and adapt to it.

The Charter of Fundamental Rights of the European Union recognizes the right of the person to access health prevention and to receive medical treatment (2). In Italy, this concept is expressed in Article 32 of the Constitution which establishes the protection of health as a fundamental right of the individual and in the interest of the community.

The ambition of WHO, endorsed later by European Institutions, was to overcome a negative definition of health as the absence of disease and to bring back physical, mental and social aspects in the conception of health. This definition stresses the necessity of « the achievement of the highest possible level of health for all » (3). The challenges that have arisen from 1948 to the present day have been moved to a tremendous increase in chronic and non-communicable diseases (4). So, the achievement of the WHO goals goes through the modification of a silent enemy, which impact dramatically on health systems and to the future of entire generations: wrong habits and improper lifestyles. Above all,

the importance of physical inactivity, as has been demonstrated, is linked to major health problems: physical inactivity is the fourth leading cause of death worldwide (5). The recent pandemic itself has shown how much a general wellbeing status of a certain population can make the difference in case of emergencies, where the fragile categories suffer of a lack of health assistance and of the reduction of availability of prevention programs and social support forces. In addition, the COVID-19 pandemic had a tremendous effect on lifestyle (eating behaviour and physical activity)(6).

Habits are the component elements of lifestyles, more than ever talking about health (7). They can be defined as common practices, rituals, customs, conventions or routines, represent norms of social action defining as an individual is seen in the eyes of others (8-10). In fact, a consistent part of habits can be considered as prototypes, interpretative keys of the belonging of individuals to a specific cultural context that generates, motivates and strengthens them, affirming themselves through them (11). In other words, they are the results of cultural imaginaries, the experiential products of the collective will, the expression of value systems and symbolic priorities (12-15). These habits are, in turn, the cultural signifiers of the choices at the root of many daily actions. The set of habits that make up the life of each individual, not infrequently helps to define his/her lifestyle and influence his/her daily behavior. In this perspective, lifestyles can be considered culturally structured and sustained models, which explain individual behaviors and choices and strongly influence the health status of those individuals.

Even if sociology makes us aware of the importance of socialization processes to support the conduct of correct lifestyles in adolescents and young adults, a reduced number of studies focus on how much habits (in particular) and lifestyles (in general) are not only influential in terms of health, but how much the presence of a structured social system intervenes in this relationship (17-22). In this regard, sociability is considered not only as the result of a socio-economic status, but also as a long-term result of the interaction between social agents during socialization processes at a younger age and subsequent resocialization processes discerned by subjects through perceived stability and relational satisfaction (8,11,23-25).

Understanding individuals' lifestyles is essential to many scientific disciplines as varied as sociology, psychology, medicine and sport science, and in the last decades their study has incessantly grown as an important factor of public health. However, despite their significant influence on physical and mental health of human being, millions of people still follow unhealthy lifestyles. In general, they are linked to the early adoption of healthy living habits, so individuals following healthy lifestyle behaviors can withstand health risks in later life. For this reason, there is the necessity to evaluate the lifestyle status of students, in order to promote and eventually correct their lifestyle behaviors with intervention programs.

In general, University students may be considered vulnerable to behavioral changes, both positive or negative, since going to the university involves new habits and friendships that can be reflected in the everyday lives. Along the years several studies showed that often university students are minimally engaged in health-promoting behaviors and expose themselves to different behavioral health risks, such as tobacco use, alcohol abuse, improper diet and low level or even absence of physical activity. For instance, a recent study of Gomez et al. (2020) showed a tendency for clustering of risk factors (smoking, diet and physical inactivity) among Spanish university students. Thus, related literature

highlights the need of having preventive assessments of university students to promote and develop healthy behaviors.

Specific biomedical markers, like advanced glycation end products (AGEs), can be selected to detect not healthy lifestyles (26). AGEs are formed by nonenzymatic reactions between sugars and amino groups of macromolecules, such as proteins, lipids, and nucleic acids (27). The formation and accumulation of AGEs progress under inflammatory and oxidative stress conditions, as well as food- or tobacco-derived AGEs may have a pathogenic significance in several chronic diseases (28). AGEs production is part of normal metabolism, and AGEs levels increase with aging, however its accumulation is also inherently linked to individuals' lifestyle. In fact, lifestyle choices have a significant effect on total body AGEs load. The exposure to specific lifestyles as diet habits, alcohol consumption, cigarette smoke, reduction of physical activity can increase AGEs levels (29). Lifestyle is also associated with sRAGE (soluble receptor for AGE) levels and, in turn, lifestyle choices have a significant effect on total body AGEs load, expression/action of RAGE (receptor for AGEs) and its isoforms, and resulting metabolic consequences. Physical activity and lifestyle intervention may be effective in increasing serum sRAGE levels. In fact, exercise is positively associated whereas diet (e.g., meat consumption), smoking duration, working time and sedentary time are negatively associated with serum sRAGE levels. In addition, it has been recently suggested the interaction of the AGEs pathway with the oxytocin (OT) system. RAGE is a newly identified molecule as an OT binding protein: it transports OT from the blood into the brain and regulates brain functions (30). Unbalancing of the AGE pathway could affect social behavior (31). Hence, the necessity to assess the AGEs accumulation.

AGEs levels in plasma and in skin extracellular matrix undergo different variation dynamics, and skin values can be more informative for the analysis of long-standing effect (32).

The analysis of AGEs levels through skin autofluorescence (SAF) is a non-invasive, rapid, and validated method for clinical use. In fact, although several confounding factors exist (e.g.; such as skin pigmentation and skincare cream use) SAF can be considered an effective biomarker that is highly correlated with serum AGEs concentrations and more importantly able to show long-standing AGEs accumulation that is associated with tissue and end organ damage (33,34). The use of SAF can also be seen as an effective tool to evaluate lifestyle behaviors and may have potential for preventative health education of university students (and population in general).

Considering the importance to monitor university students' lifestyles and how these are associated to health conditions, this study has a twofold purpose:

- 1) to evaluate lifestyle (through parameters related to eating habits, sleep and physical activity) and the relational plan, sociality, as perceived by the interviewees, in university students
- 2) to assess how these aspects correlate with health condition, monitored through advanced glycation end products measurements.

## Research design

The study takes into consideration two groups of University Students, coming from two different Universities, one of which is explicitly dedicated to physical activity.

In particular, the study intends to correlate health conditions (also by resorting to AGE values, later on); their lifestyle (through parameters related to eating habits, sleep and physical activity) and the relational plan, sociality, as perceived by the interviewees, to investigate the dynamics of interaction.

## Methodology

A total of 110 students from two Italian universities were included in the study. The students were from the Faculty of Science of Movement, and from the Faculty of Medicine.

A written informed consent was obtained from all participants and data were collected in respect on the national privacy law. All subjects recruited in this study underwent to an AGEs accumulation assessment through skin autofluorescence (SAF) (33,34). A questionnaire, containing an anamnestic section, a physical activity evaluation section, and a sociological section, was administered to each participant. An interviewer was always present during questionnaire administration in order to eventually explain specific questions. The physical activity evaluation section consisted of the validated International Physical Activity Questionnaire (IPAQ) questionnaire (35).

## Data analysis

The central purpose of the data analysis conducted was to identify two groups of students on the basis of their degree of sportsmanship and to verify if the anamnestic variables such as AGE were in any way associated with lifestyles attitudes that we could define as “healthy” and with social-related factors. A non-hierarchical cluster analysis was performed on the collected data (36,38). This technique made possible to group students into two categories, sporty and sedentary, on the basis of certain characteristics regarding the amount of sporting activity conducted daily and weekly. Eight variables have contributed to the formation of the two student groups. They concern the sports activity carried out by each subject taking into account frequency (days, minutes) and intensity (moderate, intense etc.). This technique allowed to group the cases maximizing their internal homogeneity and external heterogeneity, creating groups as similar as possible within themselves and dissimilar between them. Specifically, as can be seen in Table 1, the two clusters differ in the values assumed by each case on the 8 selected cardinal variables. The first cluster is made up of subjects who have higher values for the variables, indicating greater physical activity; the second cluster is characterized by lower values, with the exception of the item referring to sedentariness. The clustering algorithm used is K-means, which makes it possible to decide a priori the number of clusters to be formed and bases the assignment of cases to individual groups on the values closest to the centroid. In extreme synthesis, the centroid represents the average of all points belonging to the cluster. The cases are included and excluded from the cluster based on the distance they have from the centroid. In our case, it was decided to group the cases into only two clusters. This choice was made for several reasons.

On a theoretical level, previous literature suggests that blood glucose levels change as the adoption of healthy lifestyles varies. Secondly, at the empirical level, the preliminary mono- and bivariate analyses of the data had suggested the division of the reference sample into two types, one more devoted to sports and the other less so. The analysis of the groups carried out on the SPSS program vers. 22 included 76 cases in the analysis. The first cluster consisted of 51 cases, with the second, smaller cluster consisting of 25 cases.

*Tab.1- Variables that contributed to cluster formation*

Variables	Cluster 1 Sporty Students	Cluster 2 Sedentary Students
Vigorous physical activity days last week	<b>3,59</b>	2,64
Minutes of weekly vigorous physical activity	85,42	88
Moderate physical activity days weekly	3,29	2,12
Minutes of moderate physical activity active days	<b>80,04</b>	45,36
N° of weekly walking days	6,12	5,72
Average minutes daily walking	60,1	40,4
Average minutes sitting weekly	<b>181,47</b>	<b>495,2</b>
hours of sport practice	2,1	1,76

Once the two groups were formed, they were characterized on the basis of variables considered “discriminating” and important for the study. In fact, it is hypothesized that there is a relationship between the lifestyle of each student and the levels of AGE and MSI and that their lifestyle is related with sociality, here measured as the current affective and family sphere. The groups were characterized by analyzing several contingency tables that show an association between the student typology, previously created through the cluster analysis, and the nominal variables available in the database of the collected information. In this regard, the data at our disposal confirm the two hypotheses. They show that those who have a healthier lifestyle, i.e., do sports and adopt healthy behaviors (e.g., do not smoke), not only have significantly lower levels of AGE, but also that their affective relationships differ. For example, those who are sedentary tend to look after affective aspects to a much higher degree, generally having more stable affective relationships, but at the same time state to be dissatisfied with the time spent with their families.

### Results and cluster analysis

The data analysis underlined the correlation between low AGE levels and healthy lifestyles (see Tab. 2, 3, 4)

Tab. 2- AGE for Alcohol Consumption

		Alcohol Consumption		
		Regularly	Occasionally	Never
AGE	Below Average	60%	43%	59%
	Near Average	-	17%	24%
	Above Average	40%	41%	17%
	Total	100%	100%	100%

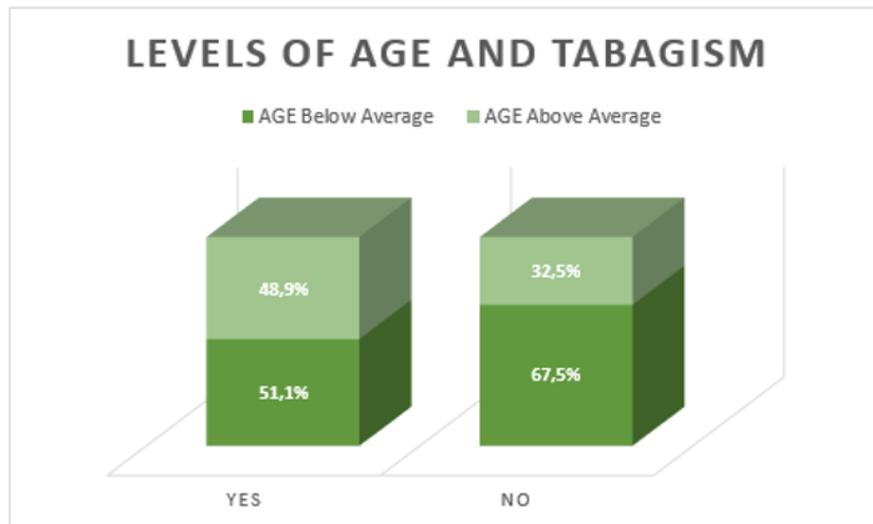
Sign. >0,05

Tab. 3- AGE for sleeping hours

		Hours of Sleep	
		<7 h	>7 h
AGE	Below Average	40,7%	59,2%
	Near Average	16,3%	20,4%
	Above Average	43,1%	20,4%
	Total	100%	100%

Sign. 0,019

Tab. 4- Smokers and No-Smokers for AGE



In order to facilitate the reading of the data, two groups of students – sporty and sedentary – were created through the clustering procedure, with the aim of understanding if there were different lifestyles and relationships among the students.

The bivariate analyses between the two clusters of students and socio-demographic characteristics as well as variables inherent to lifestyle and affectivity indicated a well-defined characterization of the groups.

Tab. 5- Student Groups

<b>Sporty Students (Group 1)</b>	<b>Sedentary Students (Group 2)</b>
Men	Women
Report spending more time more time with the family	Report spending less time with family
Tend to be more satisfied with the time spent with the family	Tend to be more dissatisfied with family time and would like to spend more time at home
Coming from Foro Italico University	Coming from the Sapienza University
Less smokers	Slightly more smokers
Mixed composition of students and workers	Mostly just students
Have slightly fewer stable relationships	Tend to have stable relationships
Graduates	High school diploma
BMI above average	BMI below average
Age below average	Age mostly above average

The first group of students, composed mostly by male subjects who were graduated from the Faculty of Science of Movement, was characterized by lower levels of AGE and higher values of BMI. The group of sedentary students, on the other hand, consisted mainly of women from the Faculty of Medicine.

Tab. 6- Typology of students for BMI

		<b>Typology of students</b>	
		Sporty Students	Sedentary Students
<b>(BMI)</b>	Below Average	12,8%	62,5%
	Near Average	48,7%	25%
	Above Average	38,5%	12,5%
	Totale	100%	100%

Sign. 0,00

Tab. 7- Typology of students for AGE

		<b>Typology of students</b>	
		Sporty Students	Sedentary Students
<b>(AGE)</b>	Below Average	60,8%	36%
	Near Average	11,8%	20%
	Above Average	27,5%	44%
	Total	100%	100%

Sign. 0,000

Tab. 8- Typology of students for smoker

		<b>Typology of students</b>	
		Sporty Students	Sedentary Students
<b>Smokers</b>	Yes	28%	8%
	No	72%	92%
	Total	100%	100%

Sign. 0,046

AGE levels confirm what the literature suggests: a healthy lifestyle reduces their deposit in body tissues. In fact, 50.3% of sports students have an AGE below the average; while 44% of sedentary students have AGE levels above the average.

Compared to the body mass index (BMI), there are interesting evidences on the youth lifestyle. First of all, it should be emphasized that sports students have a BMI close to the average in 48.7% of cases. In general, therefore, it is possible to say that there is an association between a healthy and sporty lifestyle and the BMI which expresses body mass. At first glance it might surprise that 38.5% of sports students have an above average index, but it should be considered that in the calculation of body mass not only weight related to fat affects, but also that of muscles (more developed in those who practice sports). Sedentary students do not appear to be at risk for obesity, but are mostly underweight in 62.5% of cases. The youthful lifestyle of those who do not practice sports is "inversely unhealthy": it avoids that of obesity, but exacerbates that of being underweight. Furthermore, it is well known that sportsmen also pay a lot of attention to the daily diet and are careful to take the correct number of daily calories to cope with the physical efforts they are called to sustain. Conversely, students who do not play sports may have less attention to their nutrition. Most of the reference students do not smoke, but there is a greater propensity among sedentary students: 92% of smokers are also sedentary. In conclusion, these data indicate that sports students pay more attention to their physical and relational well-being. On the relational side, it should be remembered, in fact, that a stable and lasting relationship is not necessarily an index of reliability, because some psychological determinants that lead some subjects to remain entangled in sentimental relationships even when these are not satisfactory are elusive.

Tab. 9- Typology of students for stable affective relationship

		Typology of students	
		Sporty Students	Sedentary Students
Stable Affective Relationship	Yes	47,1%	55%
	No	52,9%	45%
	Total	100%	100%

Sign. >0,05

Tab. 10- Typology of students for time spent with family

		Typology of students	
		Sporty Students	Sedentary Students
Time spent with family	Little	40%	50%
	Quite	51,4%	25%
	Very	8,6%	25%
	Total	100%	100%

Sign. >0,05

The “sporty” group of students had a rather detached affective family style and tend to have shorter and less stable relationships. Fifty per cent of sedentary students spent little time with their family, but they declared themselves satisfied with the amount of time spent.

The group of sedentary students, on the other hand, consisted mainly of women from the Faculty of Medicine, who for the most part do not work and/or have not yet graduated, considering also that the first level degree of Medicine takes a longer time to be achieved than the one of Science of Movement. This second group of subjects tended to declare stable relationships with long-lasting partners. They considered themselves dissatisfied with the time spent at home, wanting to devote more time to their loved ones. Most of the students who report spending a lot of time with their family are sportspeople (51.4%). These differences become more evident among those who declare they spend very time with family: only 8.6% of sports students, in fact, spend a lot of time with their families; on the other hand, those who are sedentary tend to spend more time with their family (25%). The interpretation of these percentages, apparently counterintuitive, could hide the willingness of sedentary students to spend more time with their loved ones. Half of the latter, in fact, say they spend little time with their loved ones; while the other half is distributed among those who claim to spend quite or very time with their family, thus expressing a negative opinion on the amount of time spent with the family. Probably, sedentary students have the perception that the time spent with the family, after all, is not quite the amount of time hoped for. It is difficult to understand whether this perception is due to objective factors (such as perhaps the greater commitment required by a stable relationship) or whether it is linked to psychological factors that lead to greater "family dependence" and the desire to be more present in the family.

## Discussion

The cognitive goal of this study meant to explore the connection between certain lifestyles, social habits and health. Given the known pervasive effects of social factors on health and sport or fitness or active lifestyle habits, the study shows that an inverse association can be also considered, both in terms of the correlation between lifestyle and health and between lifestyle and sociality. Physical activity, considered as a broad element of a young life like that one of the participants, impacts positively not only on bodies, but even on the social-mind perception of the group. In other terms, it seems that an active lifestyle has a strong effect on health, where health is considered in the inclusive sense defined by the WHO, and the adoption of valuable markers can support the evaluation of such effect (39).

Considering the clinical impact, reduced AGEs levels, measured through SAF, are associated with healthy lifestyle habits (40). In particular, regular physical activity can negatively influence tissue accumulation of AGEs (41). The data presented in this work seems in line with these observations, showing that the group with lower AGEs values is characterized by a more active lifestyle, a reduced smoking level, and a reduced BMI. Students with better lifestyles, in addition, albeit with an absolute amount of family time, seem to feel more satisfied with the family relationship than those with sedentary lifestyles. We can therefore hypothesize a correlation between more stable and mature

sociability and correct lifestyles, reserving the right to think about the terms of the causal relationship.

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### References

1. WHO (1948). Constitution of the World Health Organization, Geneva
2. EU (2000). Charter of Fundamental Rights of the European Union, 18.12.2000 Official Journal of the European Communities, C364/1
3. Jadad AR, O'Grady L (2008). How should health be defined? *BMJ*. Dec 10;337:a2900.
4. Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, Leonard B, Lorig K, Loureiro MI, van der Meer JW, Schnabel P, Smith R, van Weel C, Smid H (2011). How should we define health? *BMJ*. 343:d4163.
5. Kohl III HW, Craig CL, Lambert EV, Inoue S, Alkandari JR, Leetongin G, Kahlmeier S. (2012). The pandemic of physical inactivity: global action for public health. *Lancet*, 380(9838):294-305.
6. Lesser IA, Nienhuis CP (2020). The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. *Int J Environ Res Public Health*. 17(11):3899.
7. Abel T (1991). Measuring health lifestyles in a comparative analysis: Theoretical issues and empirical findings. *Social Science & Medicine*. 32(8):899-908.
8. Weber M. (1922/1978). *Economy and Society*, Vol. 1. Berkeley: University of California Press.
9. Cockerham WC, Abel T, Lüschen G (1993). Max Weber, Formal Rationality, and Health Lifestyles. *Sociological Quarterly*, 34, 413-43.
10. Cockerham WC, Rütten A, Abel T (1997). Conceptualizing Contemporary Health Lifestyles: Moving Beyond Weber. *Sociological Quarterly*, 38, 321-342.
11. Bourdieu P (1977) *Outline of a Theory of Practice*. Cambridge, UK: Cambridge University Press.
12. Williams SJ (1995). Theorising Class, Health and Lifestyles: Can Bourdieu help Us? *Sociology of Health & Illness*, 17, 577-604
13. Abel T, Frohlich KL (2011). Capitals and Capabilities: Linking Structure and Agency to Reduce Health Inequalities. *Social Science and Medicine*, 74, 236-244.
14. Christensen VT (2011). Does Parental Capital Influence the Prevalence of Child Overweight and Parental Perceptions of Child Weight-Level. *Social Science and Medicine*, 79, 469-477.

15. Carpiano RM (2006). Toward a Neighborhood Resource-Based Theory of Social Capital for Health: Can Bourdieu and Sociology Help? *Social Science and Medicine*, 62, 165–175.
16. Glendinning A, Hendry L, Shucksmith J (1995). Lifestyle, health and social class in adolescence, *Social science and medicine*. 41(2):235-248.
17. Rew L, Arheart KL, Thompson S, Johnson K (2013). Predictors of adolescents' health-promoting behaviors guided by primary socialization theory, *Journal for Specialists in Pediatric Nursing*, 18(4):277-288.
18. Gotlieb MR, Kyoung K, Gabay I, Riddle K, Shah DV (2015). Socialization of lifestyle and conventional politics among early and late adolescents, *Journal of Applied Developmental Psychology*, 41:60-70
19. Normandeau S, Wins I, Jutras S, Hanigan D (1998). A description of 5- to 12-year-old children's conception of health within the context of their daily life, *Psychology & Health*, 13(5):883-896
20. Yang X, Telama R, Leino M, Viikari J (2007). Factors explaining the physical activity of young adults: the importance of early socialization, *Scandinavian Journal of Medicine and Science in Sport*, 9(2):120-127.
21. Cockerham WC (2005). Health Lifestyle Theory and the Convergence of Agency and Structure, *Journal of Health and Social Behavior*, 46:51–67.
22. Vartanian TP, Houser L (2010). The Effects of Childhood Neighborhood Conditions on Self-Reports of Adult Health. *Journal of Health and Social Behavior*, 51, 291–306.
23. George VA, Johnson P (2001), Weight Loss Behaviors and Smoking in College Students of Diverse Ethnicity. *American Journal of Health Behavior*, 25, 115–124.
24. Demers A, Kairouz S, Adlaf EM, Glickman L, Newton-Taylor B, Marchand A (2002). Multilevel Analysis of Situational Drinking among Canadian Undergraduates. *Social Science and Medicine*, 55, 415–424.
25. Cockerham WC (2013). *Social Causes of Health and Disease* (2nd ed.). Cambridge, UK: Cambridge University Press.
26. Picó C, Serra F, Rodríguez AM, Keijer J, Palou A (2019). Biomarkers of Nutrition and Health: New Tools for New Approaches. *Nutrients*, 11(5), 1092.
27. Vistoli G, De Maddis D, Cipak A, Zarkovic N, Carini M, Aldini G (2013). Advanced glycoxidation and lipoxidation end products (AGEs and ALEs): an overview of their mechanisms of formation. *Free Radic Res.*, 47(Suppl 1):3–27.
28. Lin JA, Wu CH, Yen GC (2018). Perspective of Advanced Glycation End Products on Human Health. *J Agric Food Chem.* 66(9):2065-2070.
29. Turner DP (2015). Advanced glycation end-products: a biological consequence of lifestyle contributing to cancer disparity. *Cancer Res.*, 75(10):1925–9.
30. Leerach N, Harashima A, Munesue S, Kimura K, Oshima Y, Goto H, Yamamoto H, Higashida H, Yamamoto Y (2020). Glycation reaction and the role of the receptor for advanced glycation end-products in immunity and social behavior. *Glycoconj J.* doi: 10.1007/s10719-020-09956-6.
31. Higashida H, Hashii M, Tanaka Y, Matsukawa S, Higuchi Y, Gabata R, Tsubomoto M, Seishima N, Teramachi M, Kamijima T, Hattori T, Hori O, Tsuji C, Cherepanov SM, Shabalova AA, Gerasimenko M, Minami K, Yokoyama S, Munesue SI,

- Harashima A, Yamamoto Y, Salmina AB, Lopatina O (2019). CD38, CD157, and RAGE as Molecular Determinants for Social Behavior. *Cells*, 9(1), 62.
32. Almengló C, Rodriguez-Ruiz E, Alvarez E, López-Lago A, González-Juanatey JR, Garcia-Allut JL. (2021), Minimal invasive fluorescence methods to quantify advanced glycation end products (AGEs) in skin and plasma of humans. *Methods*. S1046-2023(20):30273-5.
33. Meerwaldt R et al.(2007), Skin autofluorescence is a strong predictor of cardiac mortality in diabetes. *Diabetes Care*, 30:107-12.
34. McIntyre NJ, Fluck RJ, McIntyre CW, Taal MW. (2011), Skin autofluorescence and the association with renal and cardiovascular risk factors in chronic kidney disease stage 3. *Clin J Am Soc Nephrol*. 6(10):2356-63.
35. Mannocci A, Di Thiene D, Del Cimmuto A, Masala D, Boccia A, De Vito E, La Torre G. (2010), International Physical Activity Questionnaire: validation and assessment in an Italian sample. *Ital J Public Health*. 7(4):369-76.
36. Grove W (1984). Cluster Analysis for Social Scientists. *American Journal of Psychiatry*. 141. 1297-a.
37. Di Franco G (2001). EDS Esplorare, Descrivere e Sintetizzare dati, FrancoAngeli, Milano.
38. Basole S., Stamp M. (2021), Cluster Analysis of Malware Family Relationships. In Stamp M, Alazab M, Shalaginov A (Eds.), *Malware Analysis Using Artificial Intelligence and Deep Learning*, Springer.
39. Farhud DD (2015). Impact of Lifestyle on Health. *Iran J Public Health*.;44(11):1442-4.
40. Isami F, West BJ, Nakajima S, Yamagishi S. (2018), Association of advanced glycation end products, evaluated by skin autofluorescence, with lifestyle habits in a general Japanese population. *J Int Med Res*.; 46(3): 1043-1051.
41. Couppé C, Svensson RB, Grosset JF, Kovanen V, Nielsen RH, Olsen MR, Larsen JO, Praet SFE, Skovgaard D, Hansen M, Aagaard P, Kjaer M, Magnusson SP. (2014), Life-long endurance running is associated with reduced glycation and mechanical stress in connective tissue. *Age (Dordr)* 36(4): 9665.

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