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ARTIFICIAL INTELLIGENCE AS A VISUAL COACH FOR NUTRITIONAL SELF-REGULATION IN DIGITAL ENVIRONMENTS

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ABSTRACT

This study examines artificial intelligence as a coaching and visual mediation device for dietary self-regulation in digital health environments. Using a quantitative and semiotic within-subject pre-post design, 120 adults with overweight, obesity, or mild dyslipidemia interacted for four weeks with an adaptive virtual assistant that provided feedback through recommendation cards, progress bars, categorization icons, and audiovisual microcontent. Outcomes included functional nutrition literacy, food selection, behavioral adherence, and interaction metrics. Nutrition literacy increased significantly by 14.5 percentage points ($p < 0.001$), with large effects for identifying ultra-processed foods ($g = 0.95$) and recognizing food groups ($g = 0.92$). From a visual culture perspective, visual mediation converts behavioral data into comprehensible operational cues that support situated decision-making. Findings indicate a temporal association, not a causal one, between system interaction and improved nutrition literacy.

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1. Introduction

Diet-related chronic diseases represent a structural public health challenge, since they link everyday dietary decisions to greater long-term cardiometabolic risk, a progressive decline in functional well-being, and a sustained increase in the use of health services. This relationship between unhealthy dietary patterns and the growing burden of disease has been widely documented for conditions such as cardiovascular disease, type 2 diabetes, dyslipidemia, and obesity (GBD 2017 Diet Collaborators, 2019; Ma et al., 2025; World Health Organization, 2024).

Despite the availability of clinical guidelines and evidence-based nutritional recommendations, their integration into everyday decision-making remains limited and inconsistent. These difficulties are accentuated in environments characterized by a high density of visual stimuli, where individuals must estimate portions, compare products, and evaluate food options in contexts saturated with graphic cues, marketing strategies, immediate availability, and simultaneous messages about health, pleasure, convenience, and price (Lane et al., 2024; Liang et al., 2025; Monteiro et al., 2025).

In this scenario, nutrition literacy has evolved toward a functional and situated perspective, understood as the ability to interpret, compare, and apply food information in real decision-making contexts (Carmona et al., 2025; O'Brien et al., 2024; Silva et al., 2023). These competencies are shaped fundamentally through visual processes, since identifying foods, reading labels, and evaluating everyday choices rely on images, color codes, and graphic interfaces that mediate comprehension and action (Moore et al., 2018; Vitale et al., 2023).

From this perspective, digital nutrition interventions can be understood not only as information channels but as environments of visual mediation that organize the user's experience, structure attention, and condition the processes of nutritional self-regulation (Hietbrink et al., 2025; Vanwinkelen et al., 2026). The usefulness of digital systems depends less on their technological complexity in isolation and more on their capacity to translate data into comprehensible, timely, and actionable visual representations (Curtin et al., 2025; Kelly et al., 2016; Salas-Groves et al., 2023).

The incorporation of artificial intelligence adds an adaptive dimension to digital interventions by enabling the analysis of behavioral patterns, the selection of content, and the generation of personalized feedback. In this study, this function is integrated into a visual coaching system that transforms behavioral data into recommendations, progress indicators, and audiovisual microcontent aimed at facilitating the interpretation of information and nutritional decision-making. From this perspective, AI acts as a mediating component that organizes and presents contextualized information without replacing the user's deliberative capacity (Panayotova, 2025; Wang et al., 2025; Hietbrink et al., 2025; Mohd Daud et al., 2025).

The present study analyzes a virtual nutrition assistant conceived as an AI-mediated visual coaching system and empirically evaluated in 120 adults with overweight, obesity, or mild dyslipidemia. The system records interaction patterns, selects relevant audiovisual content, and provides personalized feedback, prioritizing visual mediation as a mechanism for supporting nutritional self-regulation.

The central argument is that the usefulness of these systems does not depend exclusively on their analytical capacity, but on the articulation between data, visual representation, and user interpretation. From this perspective, the study contributes to the field of visual culture and digital health by examining the interface as an active device of mediation between information, perception, and behavior (Silva et al., 2023; Vanwinkelen et al., 2026).

2. Theoretical and visual framework

In the present study, visual coaching is conceptualized as a strategy of behavioral support mediated by dynamic graphic representations and structured mechanisms of visual feedback. Its purpose is to facilitate the observation, interpretation, and progressive regulation of behavior by transforming complex information into perceptually accessible and potentially actionable stimuli.

Unlike conventional digital coaching, which relies predominantly on reminders, notifications, and automated textual feedback, visual coaching incorporates graphic indicators, iconographic resources, progress narratives, visual categorization systems, and audiovisual content that favor the synthesis, prioritization, and contextualization of information relevant to decision-making.

The incorporation of artificial intelligence adds an adaptive dimension to digital interventions by making it possible to analyze interaction patterns and select pertinent content. In this study, this

capacity is integrated into a visual coaching system that converts behavioral data into recommendations, progress indicators, and audiovisual microcontent aimed at supporting everyday nutritional decisions.

In order to specify the conceptual scope of visual coaching and differentiate it from related approaches, a functional distinction was established between digital coaching, automated coaching, visual coaching, and visual mediation. This differentiation makes it possible to situate the proposed construct within the field of digital interventions and to identify the specific role of visual representation in the organization and interpretation of behavioral information (Table 1).

Table 1. Conceptual delimitation of the coaching and mediation approaches used in the study

Concept	Main function	Distinctive element
Digital coaching	Monitoring of and feedback on behavior by means of digital tools	Uses digital technologies as a support for behavioral guidance
Automated coaching	Algorithmic generation of recommendations and feedback from user data	Partially or fully automates the selection and delivery of guidance
Visual coaching	Behavioral support mediated by visual representations aimed at facilitating interpretation, reflection, and action	Integrates data, feedback, and visual resources to make behavioral patterns, changes, and trajectories perceptible
Visual mediation	Process of constructing and interpreting meaning through codes, signs, and visual representations	Operates as a semiotic mechanism through which information is organized, acquires meaning, and can guide interpretation and action

Source: Authors' own elaboration based on the conceptual integration of Michie et al. (2013), Kelly et al. (2016), Vitale et al. (2023), Panayotova (2025), and Wang et al. (2025).

On the basis of this delimitation, visual coaching is understood as a differentiated strategy in which visual mediation links behavioral data, their representation, and the user's interpretation. Interaction records are thus transformed into visual resources aimed at fostering reflection, decision-making, and self-regulation.

The rationale for the intervention rests on the convergence of theories of behavior change, functional nutrition literacy, and visual communication, articulated from a perspective in which artificial intelligence is understood as a technology of mediation. Under this approach, self-monitoring, feedback, goal setting, and reinforcement are relevant mechanisms for modifying and maintaining behaviors. Their integration into digital environments makes it possible to represent behavior and its evolution over time visually, with the aim of supporting everyday processes of self-regulation (Michie et al., 2013; Naja et al., 2024; Curtin et al., 2025).

Within this framework, functional nutrition literacy is conceived as a multidimensional construct comprising the recognition of food groups, the identification of ultra-processed products, the interpretation of nutrition labeling, meal planning, and contextualized food decision-making. These competencies require not only having nutritional information available, but also interpreting it, prioritizing it, and translating it into choices applicable to specific situations of everyday life, a process in which operations of visual interpretation and signification take on particular relevance (Silva et al., 2023; Carmona et al., 2025; O'Brien et al., 2024).

These domains have a relevant visual dimension, since applying nutritional knowledge involves recognizing images, comparing graphic information, categorizing cues, and interpreting symbolic representations present in the food environment. In this context, visual communication plays a structuring role by directing attention, establishing informational hierarchies, and reducing the cognitive demands associated with complex information. Digital interventions can therefore be understood as systems of mediation that organize and contextualize information in order to facilitate its interpretation and application in everyday situations (Moore et al., 2018; Vitale et al., 2023; Kelly et al., 2016; Salas-Groves et al., 2023).

The incorporation of artificial intelligence extends this architecture of mediation by enabling systematic processes of analysis, selection, prioritization, and contextualized presentation of information. Its function within visual coaching can thus be understood as the articulation between interaction data, identifiable behavioral patterns, and visual resources aimed at providing pertinent feedback. This does not imply conferring on the system an autonomous capacity to determine the user's behavior, but rather using its analytical capabilities to structure relevant information and facilitate processes of interpretation and self-regulation (Panayotova, 2025; Wang et al., 2025).

From an ethical and epistemological perspective, this function requires preserving the user's decisional autonomy and maintaining the intelligibility of the mechanisms by which information is selected and represented, avoiding configurations characterized by algorithmic opacity, implicit normativity, or punitive mechanisms of behavioral control, so that artificial intelligence operates as an adaptive mediation between information, context, and experience, and not as a substitute for individual deliberation (Mohd Daud et al., 2025; Hietbrink et al., 2025).

From the standpoint of visual culture, these mediations are relevant because digital interfaces are not neutral carriers of information, but devices that participate in the construction of meanings associated with what is healthy, desirable, and attainable. They do so by determining which dimensions of eating behavior become visible, through which codes they are represented, and how trajectories of progress are visually configured. The interface can therefore be understood as an interpretive device that organizes the user's relationship with information and with the representation of their own behavior (Vitale et al., 2023; O'Brien et al., 2024).

Consequently, the analysis of digital interventions applied to nutrition requires consideration not only of their behavioral outcomes, but also of the processes by which data are selected, prioritized, transformed, and visualized. It is precisely in this operation of translation that artificial intelligence acquires its mediating character, by converting behavior-derived information into representations that can be interpreted and used to guide decisions and support processes of self-regulation in everyday contexts (Silva et al., 2023; Vanwinkelen et al., 2026).

On this conceptual basis, the assistant developed in the present study is configured as an AI-mediated visual coaching system that brings together data analysis, principles of behavior change, and interface design. Within it, artificial intelligence performs functions of organizing and structuring information, while visual mediation constitutes the mechanism by which that information is transformed into representations the user can interpret. In this way, the system provides visual feedback and accompanies food decision-making processes without replacing individual agency or issuing autonomous prescriptions, thereby articulating a functional sequence between data, processing, visual representation, interpretation, and behavioral self-regulation (Michie et al., 2013; Panayotova, 2025).

3. Objectives

The general objective of the study was to analyze artificial intelligence as a visual coaching system in nutritional self-regulation, evaluating its function as a mediator between user behavior, available information, and its representation in digital environments, in a sample of 120 adults with overweight, obesity, or mild dyslipidemia after four weeks of use.

The specific objectives were: first, to estimate the inferential, within-subject changes in overall and domain-specific functional nutrition literacy resulting from interaction with the system; second, to describe variations in the selection of healthy foods and in nutritional adherence in everyday contexts; third, to characterize the process indicators associated with digital interaction, including duration of use, frequency of participation, and the congruence of food choices; and fourth, to analyze the role of artificial intelligence as a visual coaching mechanism, particularly in observing behavior, selecting relevant content, and generating personalized feedback through visual representations such as recommendations, progress indicators, and audiovisual microcontent.

Given that the study was framed within an analytical within-subject pre-post design supported by an a priori calculation of statistical power (>99%), the objective was to determine the statistical significance and magnitude of the changes observed in nutritional self-regulation after exposure to the system, interpreting the artificial intelligence and visualization components as an integrated intervention of behavioral support.

4. Methodology

4.1 Study design and setting

A single-group pre-post quasi-experimental design was implemented. The 120 participants were assessed at baseline and after four weeks of interaction with a digital visual coaching application based on artificial intelligence. This design was selected because of the applied nature of the study and the operational conditions of the community setting, which made random assignment and the formation of a control group difficult.

The adoption of this design responded to the pragmatic nature of research in community health settings, making it possible to assess the operational feasibility of the system, the acceptability of the interface, and the response of the indicators of behavior change under real conditions of use. Consequently, the results should be interpreted as statistically significant within-subject changes temporally associated with exposure to the system in the cohort analyzed; the design does not allow direct causal relationships to be established between the intervention and the changes observed.

The decision to employ this full-sample quantitative approach (N = 120) responded to the need to assess the changes observed, operational acceptability, and the behavior of the key indicators over the course of the intervention. The analysis was oriented toward identifying within-subject trends, interaction patterns, and the coherence between the visual components of the application and the domains of functional nutrition literacy.

In order to reduce possible sources of bias inherent in single-group pre-post designs, methodological control strategies were implemented to standardize the assessment conditions: baseline and final measurements were carried out using the same operating procedure, equivalent scoring criteria, and similar conditions of administration.

Although a concurrent control group was not included, possible external variables that could influence the results were considered, including additional exposure to nutritional information, variations in individual motivation, prior experience with digital applications, and differences in technological literacy.

These variables were addressed through homogeneous inclusion criteria, the standardized administration of the instrument, and a statistical analysis focused on within-subject changes. Nevertheless, these strategies do not make it possible to control fully for the influence of external factors, nor do they compensate for the absence of a control group. The results should therefore be interpreted as changes temporally associated with interaction with the system and as preliminary evidence of its feasibility and acceptability, without attributing causality to the intervention.

4.2 Participants, recruitment, and selection criteria

The sample consisted of 120 adults aged between 20 and 60 years, recruited from community health promotion and nutrition education programs through non-probabilistic convenience sampling. The inclusion criteria were being of legal age, having access to digital devices with an internet connection, possessing basic digital skills, providing informed consent, and presenting overweight, obesity, or mild dyslipidemia without requiring specialized clinical intervention that would interfere with use of the platform.

Convenience sampling was selected because of the applied nature of the study and the need to evaluate the functioning of the system under real conditions of use. This made it possible to recruit users with different sociodemographic profiles and levels of digital literacy, favoring the assessment of the system's applicability in everyday scenarios.

Individuals with active eating disorders, decompensated metabolic disease, or cognitive conditions that would limit autonomous interaction with the platform were excluded. This defined a pragmatic and heterogeneous sample, suitable for exploring the behavior of the system under conditions close to everyday use, in which heterogeneity in digital experience and educational level was a relevant element for examining the application across different user profiles.

4.3 Description of the visual coaching system

The application was designed as a digital visual coaching environment intended to support nutritional self-regulation through continuous interaction with the user. It allowed the recording of personal information, nutritional goals, food preferences, and behavioral patterns, from which it generated dynamic recommendations through a flexible, non-linear interaction that favored its integration into everyday routines without mandatory learning sequences.

The visual components of the application included progress bars associated with indicators of adherence and healthy choice, simplified recommendation cards, icons representing food groups and hydration, and audiovisual microcontent with graphic and temporal support. These elements were designed to transform abstract information into interpretable visual cues that would facilitate comprehension, decision-making, and nutritional self-regulation (Figure 1).

Figure 1. AI-based visual coaching interface for nutritional self-regulation.



Source: Authors' own elaboration based on the prototype interface of the application evaluated (2026).

4.4 Functional architecture of the artificial intelligence component

To avoid an opaque description of the term artificial intelligence, the analytical component was delimited as a supervised recommendation engine based on nutritional decision rules, descriptive interaction analytics, and adaptive content selection. It did not perform clinical diagnosis, prescribe individualized therapeutic diets, or replace professional assessment; its function was limited to organizing the information recorded by the user and converting it into contextualized visual feedback.

The input variables included frequency of use, self-reported food selection, reported adherence, change goals, responses to educational tasks, and temporal patterns of interaction. On this basis, the system classified recurrent needs, such as low hydration, low fruit selection, or difficulty recognizing ultra-processed foods, and activated content previously validated by nutrition professionals to generate outputs consisting of recommendation cards, visual reminders, progress indicators, and brief audiovisual microcontent (Figure 2).

Figure 2. Functional architecture of the AI-mediated visual coaching system



Source: Authors' own elaboration based on the prototype interface of the application evaluated (2026).

Personalization was carried out by means of predefined, traceable rules. Thus, when a user recorded a low frequency of hydration, the system prioritized a visual suggestion to drink water, whereas repeated errors in tasks involving the identification of ultra-processed foods activated educational microvideos on the visual reading of ingredients, packaging, and processing patterns. This approach made it possible to preserve explainability, limit clinically risky automatisms, and maintain user autonomy.

Human oversight was incorporated at the content design stage, in the definition of recommendation rules, and in the review of messages to avoid punitive, stigmatizing, or prescriptive instructions. In terms of safety, the system was configured as a supportive educational tool with explicit warnings about its non-diagnostic and complementary nature, and its data were analyzed in aggregated and anonymized form for research purposes.

From a computational perspective, the system corresponds to a hybrid explainable artificial intelligence (Explainable AI) architecture, based on expert-supervised decision rules and adaptive personalization mechanisms.

Although it does not employ generative models or deep learning, it incorporates automated processes of analysis, classification, and contextualized selection of information, characteristics that are recognized within contemporary approaches to artificial intelligence applied to digital health.

This approach was deliberately selected to guarantee the traceability of decisions, the interpretability of recommendations, and alignment with ethical principles of algorithmic transparency. It also makes it possible to understand the functioning of artificial intelligence as a process of explicit visual mediation in which interaction data are transformed into graphic representations and recommendations that the user can understand.

4.5 Intervention procedure

The procedure was carried out in three phases. In the baseline phase, the 120 participants completed, in person, the assessment of functional nutrition literacy and the food decision tasks. During the second phase, they interacted with the application for four weeks, recorded food choices, reviewed recommendations, and consulted audiovisual microcontent according to their needs. Finally, a post-intervention assessment was conducted under conditions equivalent to those of the initial measurement.

Process adherence was defined a priori as the completion of at least 75% of the expected interactions. This threshold was used as an indicator of sufficient exposure to the system without excluding

participants from the overall analysis, and the process information made it possible to contextualize the changes observed and to differentiate between literacy outcomes and patterns of interface use.

4.6 Ethical considerations and data protection

The study was conducted in accordance with the ethical principles applicable to research with adults, guaranteeing voluntary participation, informed consent, the possibility of withdrawal without consequences, the anonymization of data, and the explicit delimitation of the educational, non-diagnostic, and non-prescriptive nature of the application. Ethical approval was processed through the Research Ethics Committee of the Facultad de Medicina de Tampico – UAT under Folio 306-2025.

Personal and interaction data were handled in aggregated form to avoid the publication of identifiable information, ensuring that the system did not collect body images or sensitive biometric data beyond the records necessary for the educational use of the platform. The analysis database was anonymized before statistical processing, and access was restricted to the authorized research team.

4.7 Development of the functional nutrition literacy instrument

The instrument used in this study was developed specifically to assess functional competencies related to nutritional self-regulation in digital environments. It was constructed through a sequential process comprising three stages: (a) a review of the literature on nutrition literacy, food literacy, and functional food competencies; (b) the initial drafting of items aligned with the five theoretical domains defined; and (c) evaluation by expert judgment.

The content review was carried out by three specialists with experience in clinical nutrition, health education, and digital technologies applied to health, who analyzed the pertinence, clarity, relevance, and conceptual correspondence of each item with the domains assessed. The observations arising from this process made it possible to adjust the wording, cognitive complexity, and visual congruence of the proposed tasks before their final administration to the sample.

As a content validation phase, the specialists evaluated the items against four main criteria: conceptual relevance to the domain assessed, clarity of language, pertinence to everyday scenarios of food decision-making, and congruence with the visual elements used in the interface. The discrepancies identified were resolved by consensus between the development team and the participating specialists, prioritizing the correspondence between the educational objectives of the system, the proposed visual tasks, and the expected functional competencies.

In addition, as complementary evidence of the metric quality of the instrument, a preliminary analysis of internal consistency was conducted, yielding a Cronbach's alpha coefficient of 0.84, a value considered adequate for exploratory purposes. Likewise, expert judgment showed favorable agreement regarding the pertinence, clarity, and conceptual correspondence of the items with the domains assessed. These results support the use of the instrument as an operational measure of functional nutrition literacy in the context of the present study.

The procedure provided favorable preliminary evidence of content validity for the assessment of competencies in the cohort analyzed (N = 120). These results constitute a basis for future phases of psychometric validation aimed at examining temporal stability through test-retest, factor structure, convergent validity, and comparison with standardized nutrition literacy instruments.

5. Measures and analysis

The main variables of the study included functional nutrition literacy, the selection of healthy foods, and adherence to nutritional recommendations, assessed by means of structured instruments and decision tasks administered in in-person assessments before and after the follow-up period in the 120 participants. Functional nutrition literacy was operationalized through five domains: recognition of food groups, identification of ultra-processed foods, basic interpretation of nutrition labeling, planning of balanced meals, and everyday food decision-making in simulated scenarios, understood as competencies that involve the ability to interpret and apply information in real contexts.

The operational instrument was designed with a functional and quantitative logic, in which each domain included recognition, comparison, or decision-making tasks scored as the percentage of responses congruent with previously defined nutritional criteria. Its structure was reviewed by nutrition professionals to ensure the pertinence of the content, the clarity of the instructions, and the

correspondence between the items and the domains assessed, with priority given at this stage to content validity and the operational usefulness of the instrument for the cohort analyzed (Table 2).

Table 2. Operationalization of the domains of functional nutrition literacy

Domain	Type of task	Scoring criteria	Visual relationship
Recognition of food groups	Identification of foods and grouping by category	Percentage of correct responses	Recognition of images, icons, and color categories
Identification of ultra-processed foods	Differentiation between minimally processed and ultra-processed foods	Percentage of congruent classifications	Visual reading of packaging, ingredients, and processing cues
Nutrition labeling	Basic interpretation of front-of-pack information and the nutrition facts table	Percentage of appropriate decisions	Visual comparison of labels, numbers, and warnings
Meal planning	Composition of balanced options in simulated scenarios	Percentage of healthy combinations	Visual organization of the plate and balance of groups
Everyday food decision-making	Selection among contextualized food alternatives	Percentage of congruent choices	Visual application of criteria in purchasing or consumption situations

Source: Authors' own elaboration based on study data and prototype records (2026).

Each domain was scored on a percentage scale from 0 to 100 points: responses congruent with the established nutritional criteria received a positive score and incorrect responses received a value of zero. The score for each domain was calculated as the percentage of correct responses out of the total number of tasks assigned, and the overall score corresponded to the simple average of the five domains assessed. This strategy facilitated the practical interpretation of the results and the comparison of performance across domains with different numbers of items.

The secondary variables corresponded to process indicators intended to contextualize the changes observed during exposure to the AI-mediated visual coaching system and the intensity of user engagement, including the average duration of interactions, the proportion of responses congruent with healthy recommendations, and the frequency of participation during the follow-up period. Process adherence was defined as the completion of at least 75% of the expected interactions, as a minimum threshold of engagement for interpreting the changes observed.

Prior to the inferential analyses, the distribution of the pre-post differences was examined using the Shapiro-Wilk normality test. The assumptions of independence of observations, absence of severe outliers, and consistency of measurements were also verified before the corresponding statistical tests were selected. When the pre-post differences were approximately normally distributed, Student's t-test for paired samples was used; when this assumption was not met, the Wilcoxon signed-rank test was employed.

The statistical analysis included descriptive procedures using means, standard deviations, frequencies, and percentages to characterize the sample, the interaction indicators, and the domains of functional nutrition literacy. For the pre-post analysis, within-subject differences between baseline and final measurements were examined at a statistical significance level of $\alpha = 0.05$. The magnitude of the changes was complemented by estimating Hedges' g as a standardized effect size.

Hedges' g was interpreted as a standardized indicator of the magnitude of within-subject change, with approximate values of 0.20 considered small, 0.50 moderate, and 0.80 or higher large. The joint interpretation of statistical significance and effect sizes made it possible to characterize the magnitude of the changes observed during the period of exposure to the system, without drawing causal inferences.

From an analytical perspective, the behavior observed was interpreted in relation to the functioning of artificial intelligence as a mechanism of informational mediation and visual coaching, in which interaction data are analyzed, selected, and transformed into visual representations that guide user behavior. Changes in the main variables were examined as manifestations of the interaction between the user and the application in a visually mediated digital environment.

The visual component and the analytical support were examined in an integrated manner, with attention to their coherence with the domains of nutrition literacy and to their function in transforming abstract information into interpretable cues such as recommendations, visual indicators, and audiovisual microcontent. The joint evaluation of the components was regarded as a methodological decision aimed at preserving the integrated nature of the digital coaching process and avoiding the fragmentation of the user experience.

6. Visual analysis of the interface and symbolic mediation

To strengthen the disciplinary fit of the study with the field of visual culture, the interface was analyzed as a device of symbolic mediation and not merely as a technical support. Cards, icons, progress bars, and audiovisual microcontent are elements that organize attention, simplify the complexity of nutritional information, and produce a visual narrative of personal progress in the sample of 120 adults evaluated.

The visual hierarchy of the application was structured through brief modules designed for immediate reading, in which the recommendation cards functioned as autonomous semantic units condensing an identified behavioral problem, a concrete suggestion, and a supporting visual resource. This configuration reduced cognitive load by sparing the user from having to interpret lengthy textual instructions before acting in their everyday environment.

Food iconography performed a categorizing function: the icons for water, fruits, vegetables, food groups, and snacks facilitated the association between abstract nutritional concepts and recognizable visual objects. This operation is relevant from the standpoint of visual culture because it converts expert criteria into everyday orienting cues that can be incorporated into rapid decisions about purchasing, preparation, or consumption.

The progress bars and indicators constructed a temporal narrative of change. Instead of representing eating behavior as absolute compliance or non-compliance, these resources showed partial, cumulative, and modifiable trajectories. The visualization of progress allowed the cohort analyzed (N = 120) to observe their own behavior as a process and not as a final judgment, which is consistent with a non-punitive model of support.

The audiovisual microcontent added a further pedagogical dimension by combining image, sequence, demonstration, and temporality. Its value lay not only in transmitting information, but in showing visually how to recognize an ultra-processed food, how to build a balanced plate, or how to select snacks; this logic of visual demonstration favors situated learning and transfer to everyday scenarios.

The representation of "the healthy" was approached by avoiding normative images centered on the body, guilt, or strict control; instead, the interface prioritized cues of choice, balance, hydration, and planning. This decision is relevant because the visual culture of health can reproduce body stigma or moralizing models of self-care, and the design was oriented toward building agency without reinforcing punitive discourses about weight or eating.

Taken together, the interface operated as an interpretive environment in which behavioral data were reorganized into a comprehensible visual grammar. Visual mediation was not an aesthetic add-on but the mechanism that made it possible to translate nutritional information, interaction patterns, and recommendations into possible actions. This reading situates the contribution of the study at the intersection of visual culture, digital health, and explainable artificial intelligence.

7. Results

The sample consisted of 120 adults aged between 20 and 60 years, with a mean age of 36.8 years (SD = 9.4), a sex distribution of 72 women and 48 men, a heterogeneous educational level, and high overall adherence, since 85% of the participants completed at least 75% of the established follow-up interactions (Table 3). These levels of participation reflect sustained interaction with the application that is compatible with its use in everyday digital health contexts.

Table 3. General characteristics of the sample

Variable	Value
Total sample	120
Age range	20-60 years
Mean age (SD)	36.8 (9.4)
Sex (women/men)	72 / 48
Educational level	Heterogeneous (diversity of academic background)
Adherence >=75%	85%

Source: Authors' own elaboration based on study data and prototype records (2026).

The baseline assessment showed a moderate level of functional nutrition literacy in the cohort analyzed. Greater difficulties were identified in the identification of ultra-processed foods and the

interpretation of nutrition labeling, whereas the recognition of food groups showed relatively better performance. This profile is congruent with the gaps observed between general knowledge and situated nutritional decision-making.

The process indicators revealed interaction patterns consistent with active use of the application by the 120 participants, with an average session duration of 17.6 minutes (SD = 3.9), a mean percentage of responses congruent with healthy recommendations of 74.2% (SD = 7.8), and an average of 9.4 activities completed per interaction (SD = 2.6) (Table 4). These results suggest a sustained level of engagement and the functional integration of the system into the everyday dynamics of the sample evaluated.

Table 4. Interaction and adherence metrics during the visual coaching intervention

Indicator	Mean	SD	Minimum	Maximum	Functional interpretation
Duration per interaction (minutes)	17.6	3.9	10	25	Level of sustained involvement in the use of the application
Congruent healthy responses (%)	74.2	7.8	56	90	Indicator of behavioral alignment with personalized recommendations
Activities per interaction	9.4	2.6	5	15	Level of active participation in the visual coaching process

Source: Authors' own elaboration based on study data and prototype records (2026).

The overall functional nutrition literacy score increased from 61.4% at the initial assessment to 75.9% after four weeks of use in the cohort of 120 adults, representing an absolute difference of 14.5 percentage points. In addition, 68% of the participants achieved increases equal to or greater than ten percentage points, a threshold used as an operational criterion for characterizing the relevance of the behavioral change achieved (Table 5).

Table 5. Pre-post change in overall functional nutrition literacy

Measure	Pre mean (%)	Post mean (%)	Change (pp)
Overall composite score	61.4	75.9	+14.5
Participants with an improvement of ≥ 10 pp	--	--	68%

Source: Authors' own elaboration based on study data and prototype records (2026).

The inferential analysis by domain showed the largest statistically significant gains ($p < 0.001$) in the identification of ultra-processed foods (58% to 76%; $g = 0.95$) and the recognition of food groups (63% to 80%; $g = 0.92$), both with large effect sizes. Label interpretation and meal planning registered improvements of 13 percentage points with moderate-to-large effects, while everyday decision-making showed an increase of 11 percentage points with a moderate effect (Table 6).

Table 6. Pre-post changes by domain, statistical significance, and effect size

Domain	Pre mean (%)	Post mean (%)	Delta (pp)	Hedges' g	p
Recognition of food groups	63	80	+17	0.92 → Large	< 0.001
Identification of ultra-processed foods	58	76	+18	0.95 → Large	< 0.001
Nutrition labeling	55	68	+13	0.72 → Moderate to large	< 0.001
Meal planning	60	73	+13	0.70 → Moderate to large	< 0.001
Everyday food decision-making	61	72	+11	0.60 → Moderate	< 0.001

Source: Authors' own elaboration based on study data and prototype records (2026). Note. Δ = absolute difference between pre and post measurements expressed in percentage points; g = Hedges' g as a standardized measure of effect size. Statistical significance was set at $\alpha = 0.05$.

In terms of the functioning of the application, the artificial intelligence component operated as a facilitator of the process of nutritional self-regulation by analyzing behavioral patterns, selecting relevant content, and translating it into personalized recommendations and audiovisual microcontent. This mechanism proved particularly pertinent for addressing the recurrent needs observed in the 120

participants, such as increasing fruit consumption, improving hydration habits, reducing ultra-processed choices, and supporting the planning of balanced meals (Table 7).

Table 7. Functions of artificial intelligence as visual coaching in the mediation of nutritional self-regulation

AI component	Function in AI-mediated visual coaching	Mediation function	Domain of nutritional self-regulation	Applied example
Personalized recommendations	Analysis of consumption patterns and generation of tailored suggestions	Translation of behavioral data into concrete actions	Selection of healthy foods	Add a piece of fruit to your mid-morning snack
Hydration suggestions	Identification of low-intake habits and behavioral reinforcement	Making basic self-care behaviors visible	Nutritional adherence	Increase your water intake to 6–8 glasses a day
Balanced meal recommendations	Integration of food preferences and patterns	Practical guidance for nutritional planning	Meal planning	Try a dinner with vegetables and protein
Short educational videos	Selection of visual microcontent according to detected needs	Facilitation of comprehension through audiovisual representation	Functional nutrition literacy	How to build a healthy plate
Videos on ultra-processed foods	Identification of difficulties in food recognition	Reconfiguration of food categories through visual representation	Identification of ultra-processed foods	How to recognize ultra-processed foods
Videos on snacks	Detection of between-meal consumption patterns	Proposal of accessible and contextualized alternatives	Everyday nutritional decision-making	Five healthy snack ideas

Source: Authors' own elaboration based on study data and prototype records (2026).

The visual mediation associated with the application made it possible to transform behavioral patterns into comprehensible cues through recommendation cards, food icons, and brief audiovisual content, facilitating the interpretation of information and its application in the everyday contexts of the sample studied. These elements operated as orienting supports that made nutritional goals visible and promoted decision-making without resorting to punitive feedback mechanisms.

Since the visual and analytical components were not evaluated independently, their specific contribution cannot be isolated within the integrated intervention. Nevertheless, the correspondence observed between the domains with the greatest changes and the content prioritized by the application is consistent with the proposed function of visual coaching mediated by artificial intelligence, although this association does not make it possible to establish the causal contribution of its individual components.

8. Discussion

The findings show favorable changes in different dimensions of functional nutrition literacy after four weeks of interaction with the system. The greatest improvements were observed in the recognition of food groups ($g = 0.92$) and the identification of ultra-processed foods ($g = 0.95$), domains closely related to processes of visual recognition and categorization. These results are compatible with the possibility that repeated exposure to organized graphic cues facilitates the construction of operational categories for interpreting food information, although the pre-post design without a control group prevents causality from being attributed to the intervention.

The more moderate improvements in meal planning and everyday decision-making reflect the greater complexity of these behaviors, which are conditioned by food availability, economic resources, time, family preferences, and sociocultural practices. For this reason, visual coaching can support the interpretation and orientation of decisions, but cannot by itself modify the contextual determinants of eating (O'Brien et al., 2024; Vanwinkelen et al., 2026).

From the standpoint of visual communication, the results support the consideration of the interface as a functional component of the intervention. Cards, icons, progress indicators, and microcontent make the data processed by the system perceptible and allow contextualized feedback to

be presented. AI therefore operates as an analytical and content-selection resource, while the interface constitutes the space in which that information takes on a form the user can interpret (Vitale et al., 2023; Hietbrink et al., 2025; Panayotova, 2025; Wang et al., 2025).

The audiovisual microcontent and the non-punitive communicative tone complement this process by favoring a presentation that is brief, accessible, and oriented toward individual agency. However, the design used does not make it possible to estimate independently the specific contribution of these components.

Taken together, the study proposes visual coaching as a useful category for analyzing digital interventions in which computational processing and visual representation are combined to support everyday processes of nutritional self-regulation.

9. Ethical implications and limits of artificial intelligence as a visual mediator

Although the changes observed suggest that artificial intelligence can be a supporting resource for processes of interpretation and nutritional self-regulation, its incorporation requires a critical assessment of the limitations inherent in algorithmic personalization. The selection and prioritization of content depend on the quality, diversity, and representativeness of the data, as well as on the rules by which they are processed, a circumstance that can reproduce or amplify biases and generate responses that are differentially pertinent for certain user profiles. Algorithmic adaptation should therefore not be assumed to be an intrinsically objective or neutral process (Mohd Daud et al., 2025; Wang et al., 2025).

Nor is the visual representation of data a neutral operation from a semiotic perspective, because every interface involves decisions of selection, prioritization, categorization, and visibility through which certain behaviors acquire greater relevance than others. Colors, icons, categories, progress indicators, and other graphic resources thus not only communicate information, but also participate in the construction of meanings associated with what is healthy, desirable, and attainable. This requires considering the sociocultural diversity of users and avoiding the presentation of implicit normative criteria as universal representations of eating behavior (Vitale et al., 2023; Hietbrink et al., 2025).

Consideration must also be given to the risk of over-attributing capabilities to artificial intelligence, particularly when personalization and the adaptive presentation of content may give users a perception of authority, accuracy, or diagnostic capacity greater than that actually built into the system. It is therefore necessary to delimit explicitly its educational and supportive function, to differentiate it from clinical assessment and professional prescription, to maintain adequate mechanisms of human oversight, and to foster conditions of transparency that make it possible to understand, at a level proportional to the risk and the context of use, how information is selected and presented, so that technological mediation strengthens user autonomy without displacing the user's deliberative capacity or professional responsibility where the latter is necessary.

10. Methodological limitations

The main methodological limitation is the absence of a concurrent control group, a condition that prevents direct causal relationships from being established between the intervention and the changes observed and requires the results to be interpreted as within-subject temporal variations associated with the period of exposure to the system. Even though standardization procedures were implemented to reduce threats to internal validity, the influence of external factors cannot be excluded, such as additional exposure to nutritional information, spontaneous changes in motivation, concomitant changes in habits, familiarization with the instruments, or contextual events occurring during follow-up.

In addition, non-probabilistic convenience sampling restricts external validity and limits the generalization of the findings to populations with different sociodemographic, educational, cultural, or clinical characteristics. The four-week follow-up period makes it possible to examine short-term changes in the variables assessed, but is insufficient to determine the temporal stability of the effects observed, sustained adherence to the system, or its possible association with clinically relevant anthropometric, metabolic, and behavioral changes in the medium and long term.

Another limitation derives from the multicomponent nature of the intervention. The simultaneous integration of algorithmic personalization, visual representations, feedback, educational microcontent, and support mechanisms prevents the specific contribution of each component to the changes observed

from being experimentally isolated. With the current design, it is therefore not possible to determine whether the differences identified are related predominantly to the selection algorithms, the visual characteristics of the interface, the educational content, their interaction, or other factors associated with the experience of use.

It should also be borne in mind that the functional nutrition literacy instrument was used as an operational tool for assessing practical competencies; its psychometric evaluation therefore needs to be extended in independent and heterogeneous samples through analyses of internal structure, consistency, stability, and other sources of validity evidence. Similarly, the visual experience was assessed predominantly through quantitative indicators, which limits the understanding of the interpretive processes by which users attributed meaning to the representations incorporated into the interface.

Consequently, future research should incorporate controlled and, where methodologically and ethically feasible, randomized designs, follow-up periods of three to six months or longer, and more diverse samples that make it possible to examine the reproducibility and sustainability of the results. It would likewise be pertinent to develop factorial designs or component studies that allow the contributions of algorithmic personalization, visual mediation, and educational content to be estimated separately, and to complement quantitative measurements with cognitive interviews, usability tests, and semiotic analyses aimed at understanding how different user profiles interpret the representations generated by the system.

Despite these limitations, the findings obtained in the sample evaluated (N = 120) provide preliminary evidence to support further research on the interaction between artificial intelligence, visual representation, and nutritional self-regulation, particularly research aimed at experimentally testing the differential effect of its components, examining the interpretation of visual representations in heterogeneous populations, and determining the sustainability of the changes observed over prolonged periods of use (O'Brien et al., 2024; Vanwinkelen et al., 2026).

11. Conclusions

The results show favorable and statistically significant changes in functional nutrition literacy after four weeks of interaction with the application, with the greatest improvements in the identification of ultra-processed foods and the recognition of food groups. Owing to the single-group pre-post design, these findings should be interpreted as within-subject temporal associations and not as causal evidence of effectiveness.

These findings are compatible with the proposal of an AI-mediated visual coaching system in which the analysis of interaction patterns and the adaptive selection of content are integrated with cards, icons, progress indicators, and audiovisual microcontent to support the interpretation of nutritional information and decision-making.

The system should be understood as an educational and complementary tool, not a substitute for professional judgment or user autonomy. Its main limitations are the absence of a control group, the short follow-up period, convenience sampling, and the impossibility of isolating the specific effect of each component of the intervention.

The main contribution of the study consists in conceptualizing and empirically examining visual coaching as a process in which artificial intelligence and graphic representation are combined to support nutritional self-regulation. Future studies should evaluate this proposal through controlled designs, longer follow-up periods, and differentiated analyses of the visual and algorithmic components.

Editorial statements

Research ethics

The research was conducted with informed consent, voluntary participation, anonymization of data, and delimitation of the educational scope of the application. The ethical approval folio number is 306-2025.

Conflict of interest

The authors declare that they have no conflicts of interest that could influence the design, analysis, or interpretation of the study.

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Data availability

The aggregated data supporting the findings can be made available upon reasonable request, provided that doing so does not compromise the privacy of the participants or the confidentiality of the anonymized database.

Use of generative artificial intelligence in the preparation of the manuscript

The authors declare that generative artificial intelligence tools were used solely as editorial support for language review, textual organization, and improvement of clarity. The scientific interpretation, the data, the results, and the final responsibility for the content rest exclusively with the authors. Generative artificial intelligence was not used to fabricate data, modify results, or replace the authors' academic analysis.

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