

# CREATING NARRATIVE-BASED ADAPTIVE LEARNING ENVIRONMENTS: AN EXPLORATORY STUDY ON AI CONVERSATIONAL AGENTS FOR OBESITY PREVENTION

## CREARE AMBIENTI DI APPRENDIMENTO ADATTIVO BASATI SULLA NARRAZIONE: UN STUDIO ESPLORATIVO SUGLI AGENTI CONVERSAZIONALI PER LA PREVENZIONE DELL'OBESITÀ

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### ABSTRACT

Starting from the recognition of obesity as a multi-consequential issue, this exploratory study examines the efficacy of an AI-driven conversational agent in supporting dietary behavior change through a narrative medicine approach. The preliminary phase of the study assessed participants' motivation, digital literacy, and emotional awareness. Initial findings highlight the relevance of personalized and gender-sensitive interventions in enhancing engagement and emotional self-regulation.

A partire dall'obesità come problematica multi-consequenziale, questo studio esplorativo analizza l'efficacia di un agente conversazionale basato su AI per un accompagnamento al cambiamento alimentare basato su di un approccio di medicina narrativa. Fase preliminare dello studio ha indagato motivazione, alfabetizzazione digitale e consapevolezza emotiva dei partecipanti. Primi risultati evidenziano interventi personalizzati e gender-sensitive per favorire engagement e regolazione emotiva.

### KEYWORDS

AI in education, conversational agents, narrative medicine, obesity prevention

IA in educazione, agenti conversazionali, medicina narrativa, prevenzione dell'obesità

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## Introduction

The prevention and management of obesity pose a significant global public health challenge that hampers efforts to achieve health equity, as highlighted in Goal 2 of the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015. Obesity is a multifactorial disease characterized by an excessive accumulation of adipose tissue, resulting from an imbalance between energy intake and expenditure. It disproportionately affects individuals with lower socioeconomic status, education, and income. Ultra-processed foods and sedentary lifestyles, contributes to the rising obesity risk (Monda et al., 2024). The risk factors for obesity extend beyond chronic physical illnesses—such as type 2 diabetes, hypertension, ischemic heart disease, and cancers—to include mental health conditions like depression, low self-esteem, and other psychological disorders. Additionally, the condition of obesity is often compounded by the experience of weight-related stigma and discrimination.

Managing a complex chronic condition such as obesity requires coordinated collaboration among general practitioners, specialists, nutritionists, psychologists, and pedagogists to implement holistic and effective strategies. This approach must acknowledge that a deep understanding of the emotional and psychological determinants of eating behaviors is essential.

Preexisting beliefs, deeply established habits, and emotional responses often serve as significant barriers to lifestyle modifications, as well as to the quality of care and treatment received by patients (Perla, 2025). This is primarily due to the tendency to attribute patients' health concerns exclusively to their weight status. Furthermore, assessments of food history are frequently regarded as intrusive, moralizing, and guilt-inducing (Tanas et al., p. 78). Research also indicates that healthcare professionals may demonstrate stigmatizing attitudes toward individuals with overweight or obesity, further impacting the quality of care (Fox et al., 2023).

These considerations underscore the approaches advocated by international organizations, which call for a comprehensive management of obesity integrating education, health, and food systems (World Obesity Federation, 2021). Considering education as a tool for empowerment and capacity building, the necessity for innovative educational resources that support person-centered strategies and empower patients to develop positive behavioral changes is highlighted.

Narrative medicine offers a recommended methodology to better interpret clinical data within the context of patients' life stories, thereby focusing on a person-centered strategy. By encouraging autobiographical narratives, patients can explore emotions, experiences, motivations, and values that influence lifestyle decisions. This approach supports the creation of flexible, personalized therapeutic education plans and enriches evidence-based medicine by incorporating subjective and social dimensions of illness through tools like diaries, interviews, and focus groups (Perla, 2012).

Within a transdisciplinary framework that integrates educational, clinical, biomedical, and technological domains, the SAFETY (perSonalized heAlthy Food pathway against obEsiTY) project, coordinated by CITEL University of Bari Research Centre in Telemedicine, focuses on creating innovative technologies and personalized nutritional interventions for overweight and obese individuals. The primary objective of the study is to evaluate the efficacy of replacement of conventional whole wheat flour with industrial products based on *Eragrostis Tef* flour on body composition and gut microbiota in patients with excess adipose tissue. The innovation lies not only in functional foods, but also in the implementation of an educational model that aims to promote patients' active involvement in their care journey by fostering the development of self-reflective and regulatory competencies through digital innovations.

Self-regulation skills are increasingly recognized as critical to educational and therapeutic success. These skills enable individuals to manage emotions and behaviors in pursuit of long-term goals and include self-monitoring and emotional and motivational regulation. Conversely, a lack of self-regulation is often associated with relational difficulties, and motivational issues such as apathy or disengagement (Zimmerman, 2000). In dietary interventions, narrative diaries help patients recognize hunger and satiety signals, manage emotional eating, and maintain motivation over time. By fostering emotional expression and real-time reflection, they enhance self-awareness and promote a constructive reinterpretation of failures. This tool integrates emotional, cognitive, and behavioral dimensions, thereby strengthening self-regulation.

In the present project, the diary has been designed to be supported by an AI conversational agent (CA) that concurrently provide researchers with data. The efficacy of the digital extension of the narrative-based educational approach will be assessed through empirical testing.

## 1. The study

This paper presents the initial steps of a pre-post exploratory study, investigating changes in patients' engagement and healthy outcomes following the introduction of project Safety's CA.

An AI-powered conversational agent is a software system designed to simulate human-like dialogue through natural language or voice-based communication. These agents function as intelligent virtual assistants, employing advanced artificial intelligence techniques to engage users in realistic and context-aware interactions. Central to their operation is Natural Language Processing (NLP), a field within AI that enables computers to understand, interpret and generate human language. NLP allows the agent to comprehend user intent and the purpose of queries, facilitating personalized and meaningful responses (Schöbel et al., 2024). AI companions, such as ChatGPT, are practical examples of this innovation engaging users in natural, human-like conversations. Such interactions foster a sense of connection and support, contributing to more immersive and responsive learning experiences (Tlili et al., 2023).

This study explores the implementation of a conversational agent designed to function as an empathic companion, facilitating data collection through dialogue to personalize care and interventions (Miccoli et al, 2025). The agent mirrors the reflective and narrative objectives of traditional journaling methods, enabling a direct comparison between narrative AI-supported and conventional approaches. The primary aim is to assess the effectiveness of AI-facilitated narrative reflection versus traditional journaling (paper or digital) among participants in the project. By integrating artificial intelligence into narrative medicine practices, the study seeks to evaluate the impact on patient engagement and health outcomes, thereby determining the potential of conversational agents to enhance personalized care strategies.

The overall objective of this study is to foster the development of an adaptive learning environment that underpins a sustainable and inclusive educational model prompting active engagement, encouraging self-reflection, and supporting health-related behavioral transformation.

The study has been designed using a within-subject design. Two narrative-based educational approaches are proposed to a group of patients who are on a diet : the traditional narrative diary and sequentially a conversational agent supporting the narrative diary.

A research protocol has been constructed based on the following research questions:

- (RQ1) How does the integration of a CA into a narrative-based dietary program influence patient engagement?
- (RQ2) To what extent does the integration of a CA into a narrative-based dietary program impact patient dietary goal?

Engagement is understood as a multidimensional construct encompassing emotional, cognitive, and behavioral components, reflecting the participant's active and purposeful involvement in the educational process. Prior studies show that interactivity and personalization—both enabled by conversational agents—are strong predictors of involvement in digital health program (Cevasco et al., 2024). Therefore, the hypothesis underlying this study are that the two modes of narrative reflection (traditional diary vs. AI chatbot) would generate different outcomes:

1. the integration of a conversational agent into a narrative-based dietary program will increase patient engagement compared to a non-interactive narrative approach. Interactivity may reduce the perceived burden of writing, even if not all patients may feel comfortable sharing deeply personal stories with a virtual agent.
2. Feedback and self-monitoring—facilitated by a CA—can improve goal-directed behaviors.

The objective of this initial phase is exploratory and aims to pilot the CA through the experiences of a selected group of early participants (the first 22 patients enrolled). This pilot will serve to evaluate the tool's relevance and emotional resonance. Based on the preliminary insights gathered, the tool will be revised and subsequently deployed on a larger scale, involving the full cohort of 100 patients as planned in the study design.

For an AI-based instrument to be considered effective, it is imperative that it is both usable and accepted by its intended users. To this end, a usability test has been conducted, as referenced in the work of Miccoli et al. (2025). Results demonstrate good accuracy in emotion recognition and positive user feedback, highlighting the CA's potential of supporting narrative medicine techniques.

## 1.2 Related work and significance of the study

The present study is situated within the emerging e-health governance model, which underscores the central role of patients, prevention, multidisciplinary, the importance of networked care systems, and the transformative potential of digital medicine. This paradigm shift promotes a patient-centred approach to healthcare, aiming to foster active participation and incorporate patients' perspectives on technical, organizational, and care-related dimensions (Perla, Massaro, 2021).

Recent studies have highlighted the potential of integrating CAs into healthcare settings. By delivering tailored content, adapting interaction styles, and fostering human-like engagement, CAs are proving to improve user retention, satisfaction and health outcomes (Cevasco et al, 2024).

These AI-driven tools not only focus on physical well-being but also address emotional health, emerging as adaptive and user-centric platforms that foster holistic well-being. Several agents have been developed specifically for mental health support through active listening, such as *Woebot* (Fitzpatrick et al., 2017), which assists individuals with anxiety and mood disorders, and *Wysa*, a chatbot that uses cognitive-behavioral therapy techniques to support users' mental health (Anand et al., 2025).

The significance of this study lies in its potential to enhance the quality and effectiveness of health education programs through a personalized approach that integrates traditional narrative reflection techniques with personalized and interactive digital tools.

Despite the growing interest in CAs within healthcare and the increasing adoption of narrative medicine as a patient-centered approach, there remains a notable lack of studies that systematically integrate these two domains. While prior research has explored the use of chatbots for emotional support, little attention has been paid to the use of CAs as facilitators of therapeutic storytelling. This study aims to address this gap by offering an original contribution at the intersection of AI, narrative-based care, and health promotion.

The results have the potential to inform the design of scalable, personalized tools for obesity prevention and dietary education, particularly among populations with low digital literacy or emotional awareness. Moreover, the study contributes to emerging research on human–AI interaction in healthcare, offering practical insights for clinicians and developers seeking to integrate empathic technologies into behavior change strategies.

## 2. Methodology

### 2.1 The SAFETY conversational agent

The Safety CA works as a personalized companion, interacting with simple sentences and narrative prompts (e.g. “Describe to me a significant change in relation to your new eating pattern”). It will engage patients with questions about their physical and mental state with functions of *coaching* (offering motivational guidance), *planning* (setting reminders), *feedback* and *self-assessment* (providing narrative prompts for self-reflection).

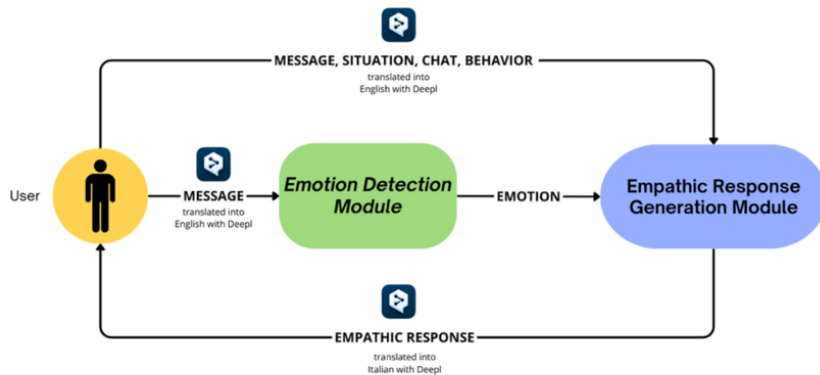


Figure 1. The CA system architecture

The CA has been implemented with two main modules (Figure 1)

- **Emotion Detection Module (EDM):** This module analyzes the user’s message and, using a text classifier based on a distilled version of the BERT model, associates it with a label representative of the emotion expressed by the user.
- **Empathic Response Generation Module (ERGM):** Starting from the emotion detected by the EDM and the associated message, this module generates an empathic response by exploiting a Large Language Model suitably refined through fine-tuning. The language model is trained not only to respond empathically to the detected emotion but also to consider the context in which the patient is, considering the user’s desired behavior in that specific emotional circumstance. The user’s message is sent to the EDM module to recognize the emotion in the user’s sentence. The detected emotion, along with the user’s message, situation, chat, and behavior, is

then passed to the ERGM module, which generates an empathetic response for the user.

The CA is designed to suggest narrative prompts and give feedback to patients. At the core of the response generation process is a Large Language Model (LLM), which produces a set of potential responses based on the user’s input, emotional context, and conversation history. These responses are then evaluated by an indicator-based scoring system, which uses psychological or behavioral indicators—such as food awareness or emotional regulation—to assess and rank the responses to give proper feedback. For each indicator, the CA assigns a value—low, medium, or high—depending on how clearly and deeply the patient expresses that dimension in their answer. Based on the assigned level, the CA adapts its response to encourage reflection and guide the patient forward. For example, if the patient shows only initial attempts at change, the CA may offer gentle encouragement or suggestions for small steps. If the patient expresses more advanced self-awareness or emotional insight, the CA offers deeper, more personalized prompts to reinforce progress and promote further exploration. This adaptive system allows the CA to engage in meaningful, supportive dialogue that aligns with each patient’s stage in their behavioral and emotional journey. E.g.: for the narrative prompt *“Describe a significant event in relation to your new eating pattern”* table 1 details the CA feedback.

| Indicator                 | Description                                           | Conversational Adaptation                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Food Awareness</b>     | Recognition of the link between emotions and food.    | <p><b>Low</b> → The AI guides the user with reflective questions: 'Have you ever noticed if you eat in response to emotions like stress or boredom?'</p> <p><b>Medium</b> → The AI reinforces awareness with practical tips: 'You could try keeping a food diary to identify moments when food becomes an emotional refuge?'</p> <p><b>High</b> → The AI reinforces good habits: 'Great that you recognized this aspect! How do you feel about your progress?'</p> |
| <b>Emotion Regulation</b> | Ability to manage stress without turning to food.     | <p><b>Low</b> → The AI suggests alternatives: 'When you're stressed, have you tried relaxation techniques like deep breathing?'</p> <p><b>Medium</b> → The AI encourages alternative strategies: 'Many find a short walk or a call with a friend helpful. Could that work for you?'</p> <p><b>High</b> → The AI celebrates progress and reinforces strategies: 'Fantastic! You've found strategies that work for you. Which one seems most effective?'</p>         |
| <b>Habit Change</b>       | Implementation of new eating and behavioral routines. | <p><b>Low</b> → The AI proposes small steps: 'Is there a habit you would like to change? We could start with a small weekly goal.'</p>                                                                                                                                                                                                                                                                                                                             |



|                      |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      |                                                   | <b>Medium</b> → The AI supports consolidation: 'You've already started changing habits! Which one has been hardest to keep so far?'<br><b>High</b> → The AI helps optimize new habits: 'You're on the right track! Is there anything we could improve or make more sustainable?'                                                                                                                |
| <b>Motivation</b>    | Level of determination in the journey.            | <b>Low</b> → The AI offers motivational support: 'I know this can be hard. What's the main reason you started this journey?'<br><b>Medium</b> → The AI reinforces motivation: 'You've made progress! What result are you most satisfied with?'<br><b>High</b> → The AI boosts self-efficacy: 'You're very motivated! Have you thought about new mid-term goals?'                                |
| <b>Self-Efficacy</b> | Perception of personal control over food choices. | <b>Low</b> → The AI guides toward small successes: 'Have you noticed a moment when you made a healthier choice than usual? Let's start from there!'<br><b>Medium</b> → The AI helps build trust: 'What helped you stay consistent in difficult situations?'<br><b>High</b> → The AI promotes autonomy: 'Do you feel confident in your choices? What strategy has been most successful for you?' |

Table 1. The conversational agent adaptation

## 2.2 Participants

22 patients have been enrolled in the project. The subjects of this study adhere to a diet that is overseen by a nutritionist. This diet is expected to be followed for a period of seven months, with a one-month break in the middle.

Inclusion criteria are:

- Age  $\geq 18$  years and  $< 75$  years;
- diagnosis of overweight or obesity grades I and II according to BMI calculation with the absence of complications as outlined in the clinical protocol of the study.

The project protocol has been approved for evaluation by the Local Ethics Committee for Clinical Trials (CEL) protecting the rights, safety and well-being of subjects participating in a clinical trial. Enrolled patients have signed an informed consent form.

## 2.3 Study design

We designed an experimental within-subject study involving a single group of participants. The research includes two sequential intervention phases, each lasting three months, with a one-month pause period in between called *washout*. The two

research phases as shown in Fig. 2 (Study phases) and detailed in Table 1 (Study phases illustration).

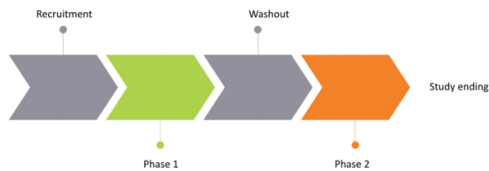


Figure 2. Study phases

| Phases         | Duration | Activity                                                              | Modality                | Notes                                                                                                    |
|----------------|----------|-----------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------|
| Phase 1        | 3 months | Personal narrative reflection through diary writing                   | Paper or digital diary  | Participants respond to narrative prompts and reflective questions                                       |
| Wash-out Phase | 1 month  | No intervention                                                       | —                       | Designed to avoid carry-over effects between interventions                                               |
| Phase 2        | 3 months | Narrative reflection supported by interaction with AI-powered chatbot | AI conversational agent | Conversational agent presents the same prompts and questions as in Phase 1, ensuring content consistency |

Table 2. Study phases illustration

In Phase 1, patients partake in a conventional narrative reflection exercise utilizing a personal diary, whether in paper or digital format, according to their preference. In Phase 2 participants engage with an artificial intelligence-powered conversational agent that utilizes the same narrative prompts as the diary. Presently, the project is in the second month of the first phase. In the second phase, the conversational agent will initiate interactions by posing targeted questions regarding the user's mood, physical sensations, and mental state. The objective is to replicate the narrative prompts and reflective questions utilised during the preliminary phase, whilst concurrently providing immediate and personalised feedback. The agent will play an active role in sustaining the dialogue to foster continuous user engagement and encourage deeper self-reflection. To minimise the influence of confounding variables, the study employs standardized narrative prompts and reflective questions across all conditions. The instructions provided to participants have been aligned to ensure consistent and

neutral delivery, thereby allowing any observed differences to be attributed exclusively to the intervention. This ensures that all participants have been exposed to the same narrative stimuli and instructions.

This methodological approach ensures that any observed variations in results are attributable exclusively to the variable under investigation (the absence or the presence of the conversational agent) and do not pertain to confounding factors.

## 2.4 Procedure and instruments

The study phases are structured into sessions, characterized by specific research tools (Fig. 3).

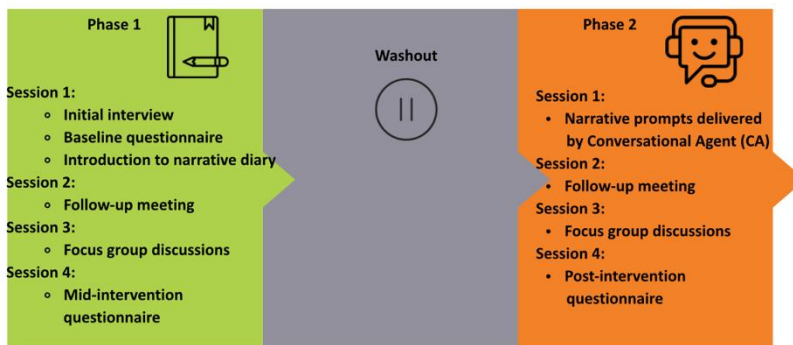


Figure 3. Research tools

In the initial phase of the programme, patients are requested to attend a preliminary consultation with the clinical nutritionists. After the nutritional assessment, participants undertake an introductory meeting with the education team, which comprises a narrative interview and a questionnaire. The interview focuses on relevant personal information, motivation for participating in the project and exploration of eating habits. A further core area of inquiry delves into the emotions associated with food. The participants then complete a baseline questionnaire evaluating motivation, digital literacy, and emotional awareness, followed by engagement with a narrative diary supported by standardized prompts. This is supposed to be completed on a weekly basis over the course of the first trimester.

Clear instructions are provided, and any questions or requests for clarification is addressed by the research team to ensure accurate and complete responses.

At the end of the first month of the dietary intervention, patients attend a scheduled medical follow-up visit and provide researchers with oral feedback on the use of the narrative diary, allowing researchers to explore the patients' engagement and any emerging difficulties or insights. The project is currently in the patient feedback phase.

This phase will conclude with the administration of a mid-term questionnaire designed to collect partial data regarding participants' engagement with the diary, emotional awareness, and emerging behavioral changes. A one-month pause will follow, allowing the medical and educational teams to review the adopted procedures and discuss the patients' progress. In the second phase, participants will interact with the AI-driven conversational agent. Upon completion, a final questionnaire will be administered to assess the overall impact of the intervention. To assess the effectiveness of the intervention, the same questionnaire administered at baseline will be re-administered after phase 2, at the end of the program. This repeated-measures design will allow for the evaluation of individual-level changes in participants' responses across key dimensions, including engagement into change, emotional awareness related to eating and healthy habits.

Focus groups with participants are planned during both phases to further explore their experiences, perceptions, and narrative development throughout the intervention.

In summary, the study envisions using several research instruments to collect both quantitative and qualitative data.

- **baseline questionnaire:**  
Assesses sociodemographic characteristics, digital literacy, physical activity, eating behaviors, the emotional influence on food choices, and self-perceived readiness and motivation to adopt dietary changes.
- **narrative diary:**  
guides participants' reflective writing using standardized prompts to foster emotional expression and self-regulation.
- **mid-intervention questionnaire:**  
captures partial outcomes following the narrative diary phase, focusing on motivation, emotional awareness, and engagement.

- **conversational agent:**  
provides narrative prompts, reflective questions, and immediate personalized feedback to support self-reflection during phase 2.
- **focus groups:**  
explore participant experiences and perceptions related to both the narrative diary and the CA.
- **post-intervention questionnaire:**  
It measures changes in engagement and self-regulation, as well as collects user feedback on the usability of the conversational agent at the end of the intervention.

### 3. Results

The purpose of this paper is to present the results of the entry questionnaire. Regarding the data collection instrument, the questionnaire has been administered through a web-based platform with interviewer assistance (Computer Assisted Personal Interviewing CAPI), ensuring participant understanding and minimizing technological barriers. It consisted of closed-ended questions divided into 5 sessions:

- Sociodemographic data (age, gender, education level, occupation)
- Technology use and digital skills
- Physical activity and health-related habits
- Eating behaviors and the influence of emotions on food choices
- Self-perceived readiness and motivation to implement dietary changes

Most questions used ordinal or categorical response scales, allowing for both qualitative interpretation and quantitative analysis.

Key contents, main findings and critical issues or relevant observations for each entry questionnaire's sections are described in Table 3.

| SECTIONS                         | FINDINGS                                                                                                                                                                                                                                          | OBSERVATIONS                                                                                              |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| 1. Demographic and context       | Participants are mostly age 56-65 with a balanced gender distribution. Common occupation include retirees, homemakers and clerks. Education levels range from elementary to high school. Most live in small towns or rural area                   | The sample represent a mature, non digitally native population with moderate exposure to technology       |
| 2. Technology use                | All respondents use digital device regularly, especially smartphones and laptops. Main uses include messaging, calling, browsing and social media. Self-reported digital skills range from basic to good, though few consider themselves experts. | There is a need for improved digital literacy, especially regarding tools related to health and wellbeing |
| 3. Lifestyle and habits          | About half of the participants engage in some form of physical activity. Most do not smoke and consume alcohol only occasionally. Sugar drinks are consumed in moderation                                                                         | Generally positive trends, indicating growing awareness of healthy behaviors                              |
| 4. Eating habits and emotions    | Some recognize the link between emotions and eating (e.g. stress). Comfort food like cheese and pizza are commonly favored. Eating patterns vary from balanced to test- or convenience driven                                                     | Emotional awareness in eating habits is limited; further education is needed to deepen this connection    |
| 5. Perceptions of dietary change | Most participants are moderately to highly engaged in moving their eating habits. Some feel informed and prepared, while others express doubts or challenges. Many believe change will improve their quality of life                              | Positive motivational potential that could be enhanced with support and tailored guidance                 |

Table 3. Key contents of questionnaires' sections

The results of the entry questionnaire reveal a respondent group with a relatively healthy baseline and a strong openness to change, especially concerning diet and lifestyle habits. Notably, 87% of participants report using digital devices on a daily basis, with smartphones (100%) and laptops (65%) being the most common. However, only 18% consider themselves to have an “advanced” level of digital competence, suggesting that while access is widespread, confidence and depth of usage are still developing.

In terms of lifestyle, 54% of respondents stated they engage in some form of regular physical activity, with walking and gym training being the most cited. Smoking is rare within the group — 71% declared they do not smoke at all — and 68% reported consuming alcohol only on special occasions. When it comes to dietary habits, 61% of participants acknowledged that their food choices are at least sometimes influenced by emotional states such as stress, anxiety, or boredom. Still, many responses revealed a superficial understanding of emotional eating patterns.

Importantly, the questionnaire also highlighted a strong motivation for dietary change: 74% of respondents said they feel “motivated” or “very motivated” to improve their eating habits, and 82% believe that such changes would enhance their quality of life. Despite this willingness, 39% expressed uncertainty about how to begin or maintain a healthier dietary path, often citing a lack of knowledge or structured support.

These findings suggest that the group is highly coachable, with a good base of awareness but in need of structured guidance, especially in three areas: emotional education around eating, digital literacy concerning health tools, and personalized strategies for behavior change. The SAFETY project can capitalize on this readiness by providing tailored interventions, clear informational pathways, and ongoing motivational reinforcement.

### **3.1 Correlation Analysis**

To refine the intervention model and understand how it makes 'digital intervention work with the CA, we investigated the association between participants' engagement and a set of explanatory variables (such as education level, confidence in personal change, emotional eating patterns, physical activity, and digital competence) employing Spearman's rank-order correlation coefficient ( $\rho$ ). This statistical measure was chosen due to the ordinal nature of the data (variables involved as engagement, confidence, education, emotions, etc. are ordinal e.g., “low,” “medium,” “high”) as a ‘thermometer’ that measures whether two aspects are moving in the same direction and how closely they are linked. Values of  $\rho$  range from -1 to +1, where values closer to  $\pm 1$  indicate stronger correlations, and a p-value < 0.05 is typically considered statistically significant.

Engagement was measured on a 4-point scale while other variables were appropriately coded into ordinal or binary numerical formats: e.g. Confidence in change: 3-point scale (1 = ‘Not at all’, 3 = ‘Very much’).

The results of the correlation analysis are summarized in Fig. 4, showing the strength and direction of the relationships between engagement and the other variables analysed.

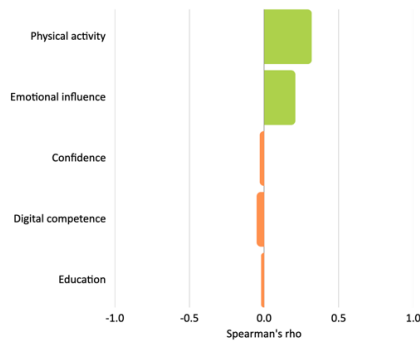


Figure 4. Spearman correlation rho with Engagement

The Spearman correlation analysis was conducted to explore associations between selected variables and engagement. The results are summarized as follows:

- Physical activity showed a moderate positive correlation with engagement ( $\rho = 0.3245$ ;  $p = 0.0749$ ).
- Confidence in change demonstrated a weak negative correlation with engagement ( $\rho = -0.2271$ ;  $p = 0.2192$ ).
- Emotional influence on eating behavior exhibited a weak positive correlation with engagement ( $\rho = 0.2125$ ;  $p = 0.2510$ ).
- Digital skills showed a very weak negative correlation ( $\rho = -0.0508$ ;  $p = 0.7861$ ).
- Education level exhibited a negative correlation ( $\rho = -0.0193$ ;  $p = 0.9178$ ).

None of the correlations reached statistical significance at the conventional threshold ( $p < 0.05$ ), although the relationship between physical activity and engagement approached marginal significance.

To conclude the analysis, a test was conducted to examine the association between gender and emotional awareness in the context of eating behavior. Specifically, the item *“Do you believe emotions influence your eating behavior?”* was analyzed in relation to participants' gender.

For this purpose, a Chi-square test of independence ( $\chi^2$ ) was applied, comparing the categorical variables “gender” (male/female) and “emotional influence on eating” (yes/no). The test showed a value of  $\chi^2 = 23.36$  with  $p < 0.001$ , indicating a statistically significant association between the two variables.

The results revealed that 94.7% of female participants acknowledged the emotional influence on their eating habits, whereas none of the male participants provided



the same response. This stark contrast highlights a substantial gender difference in the perception of the emotional-eating connection, suggesting that women in the sample demonstrated greater emotional awareness in this domain.

The emotional nature of food was further emphasized by the preliminary empirical analysis of the interviews, which highlighted that food is perceived not only as sustenance but also as a medium for memory, emotional relief, and expression. To deepen this exploration, the interview data will be analyzed using qualitative analysis software NVivo, enabling a more systematic coding of emotional themes. Overlooking the emotional dimension of food could limit the effectiveness of behavioral and nutritional interventions aimed at promoting sustainable change.

#### **4. Discussion**

The correlation analyses conducted in this study served to identify preliminary relational patterns between emotional, behavioral, and cognitive variables and user engagement within a narrative-based, AI-supported dietary intervention. Although the associations found are weak to moderate and not statistically significant, they provide valuable guidance for refining the intervention model.

The results suggest that among the variables examined, physical activity displays the most promising association with engagement in dietary behavior change, even though without reaching statistical significance. This moderate positive trend indicates that participants who maintain regular physical activity may be more likely to engage actively in behavior change processes, and that behavioral factors may have a more direct influence than purely cognitive or sociodemographic characteristics.

Conversely, the negative correlation observed between confidence in change (meant as self-assessment of perceived ability to cope with a change in eating habits) and engagement, although weak and non-significant, may indicate that highly involved participants are not necessarily more confident in their ability to succeed—potentially reflecting deeper psychological factors, such as fear of failure or previous negative experiences. High self-confidence alone may not translate into concrete action.

The weak positive correlation observed between emotional influence on eating behavior and engagement suggests that persons who recognize or experience stronger emotional drivers in their eating habits may be more inclined to actively

engage in narrative-based interventions. This slight association could imply that emotional sensitivity fosters greater openness to self-reflection and personal storytelling, which are key mechanisms in narrative-driven behavior change processes. Although the correlation is weak and not statistically significant, it highlights the potential relevance of targeting emotional awareness in designing more engaging and responsive digital interventions.

Digital skills and education level demonstrated minimal associations with engagement, indicating that in this sample, technological skill and formal education are not major determinants of involvement in dietary behavior change.

Although preliminary, these findings provide insights related to the ongoing study's aim of supporting engagement in narrative-based dietary interventions. The weak associations found highlights the complexity of the engagement process and reinforce the need for personalized and emotionally sensitive approaches, such as CAs specifically designed to adapt to users' emotional and behavioral profiles, in line with the broader objectives of the present study.

The gender-based difference observed in emotional awareness related to eating behavior carries important implications for the design of digital health tools and educational content. Since women appear more likely to acknowledge the emotional dimension of eating, resources targeting female users may benefit from the inclusion of explicit emotional tracking components, such as guided reflections, and mood-food journals. Conversely, male participants, who in this sample demonstrated significantly lower emotional recognition in relation to food, may respond more effectively to features that introduce emotional awareness indirectly. For example, tools that frame emotional states in terms of physical energy, performance, or stress levels—rather than explicitly as “emotions”—might be more approachable and engaging for this demographic.

Furthermore, gender-sensitive design can extend to tone, visuals, and language: more analytical or performance-driven narratives might better resonate with men, while empathy- and reflection-based approaches may align more naturally with women's responses. This tailoring can increase the perceived relevance, usability, and impact of interventions in contexts of behavior change and long-term health support.

Additional implication from interviews findings:

- Food is emotionally symbolic, not merely functional. Food serves as a medium for emotional continuity, memory, and identity, often used by

patients to reconnect with past experiences and cope with emotional needs.

- Emotional eating is recognized but difficult to regulate. Nearly half of the participants acknowledge that mood influences their eating choices, yet many experience difficulties in self-regulation, often leading to guilt and feelings of loss of control.
- Eating behavior is context-dependent and stress-triggered. Disorganized eating episodes predominantly occur at home, especially after work, and are strongly associated with stress, anxiety, sadness, and frustration, highlighting the need for context-aware interventions.
- Certain demographics are more emotionally vulnerable. Adults aged 46–55 with family and work responsibilities frequently express emotional depletion through food-related coping, indicating a specific target group for tailored interventions.
- Food simultaneously offers peace and pain. The emotional ambivalence of food, encapsulated by expressions like “Every bite is pain,” underscores the necessity to address both the comforting and painful aspects of eating within emotional education strategies.

## **5. Limitations and future work**

This study has several limitations that must be considered.

First, the relatively small sample size limits the generalizability of findings and may have reduced the statistical power needed to detect significant associations.

Second, reliance on self-reported data introduces potential biases, such as social desirability effects and recall inaccuracies, particularly concerning emotional eating and motivation.

Third, identified associations should therefore be considered exploratory.

The next phases of the study will center on testing the AI-driven CA. Mid-term and final assessments will track the evolution of participants' self-regulation, behavioral change and health outcomes over time.

In parallel, a systematic qualitative analysis of narrative data collected through diaries, interviews, and focus groups will provide deeper insights into the

emotional, cognitive, and behavioral dynamics associated with food-related behaviors and emotional regulation processes.

Building on these results, future work will focus on refining the conversational agent's adaptive capabilities. Enhancements will include developing more sophisticated narrative prompts that dynamically respond to users' emotional states and behavioral profiles, improving personalization and user engagement. Additionally, the expansion of the participant sample will be prioritized, allowing for a more robust understanding of how different populations interact with narrative-based digital interventions.

The aim is to contribute to the design of next-generation digital health tools that are not only adaptive and emotionally intelligent but also scalable and accessible across diverse healthcare settings.

## **Conclusions**

This study investigates the application of a narrative medicine approach through the development of an AI-driven CA, with the goal of integrating human-centered reflection and adaptive digital interaction to enhance patient engagement and influence dietary behaviors. Preliminary findings highlight the complexity of engagement dynamics and support the need for personalized, emotionally responsive digital strategies. These results reinforce the theoretical foundation for using narrative medicine in digital health contexts, emphasizing the integration of emotional and experiential dimensions into behavior change interventions.

The emotional significance of food—evident in both survey data and interviews—underlines the value of emotionally attuned, user-centered design. Gender differences in emotional awareness also emerged: women tended to recognize emotional triggers more readily, while men exhibited lower emotional insight. These findings point to the importance of gender-sensitive conversational strategies, such as empathy-based cues for women and performance-oriented framing for men.

Future qualitative analysis will further inform the refinement of the CA, aiming to tailor narrative prompts to users' emotional profiles and behavioral patterns. Ultimately, these insights suggest that engagement is less driven by static traits and more by emotional readiness and context. Therefore, AI-based behavioral interventions should include reflective and narrative elements that help users

understand the emotional roots of their eating habits, fostering deeper connection, improved self-regulation, and sustainable change.

### **Authors contributions**

LP coordinated the research and wrote Methodology par 2.2, 2.3, 2.4 (Participants, Study design, Procedure and Instruments); ADF wrote Introduction; SM par 1 and 1.1 The study & Related work and significance of the study; BDC par 2.1 The Safety CA; MTS par 3 Results; GP Discussion; VA Limitations and future work & Conclusions

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