Developing a Web-Based Intervention to Support Informed and Responsible Vitamin Supplement Use

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August 2025

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Abstract

The use of food supplements has increased significantly in recent decades, with high usage rates reported across many countries. In the Netherlands, more than half of the population reports using supplements. While public health authorities recommend supplementation only for specific risk groups, many consumers take supplements based on personal beliefs rather than scientific evidence. This raises concerns about uninformed or unnecessary supplement use. To address this issue, this study describes the development of a digital intervention that supports responsible supplement use by informing consumers about the necessity, efficacy, and safety of vitamin supplements, the most commonly used type of supplement. The intervention was developed following the first three phases of the CeHRes Roadmap: contextual inquiry, value specification, and design. This involved (1) analyzing existing research to identify consumers' needs, motivations, and difficulties related to supplement use, (2) translating these insights into values and design requirements, and (3) developing a prototype based on these values and requirements. Finally, (4) a formative evaluation with five participants was conducted to assess system and content quality, focusing on ease of use, comprehensibility, and perceived personalization. The resulting intervention was developed based on three values: informed decision-making, personalization, and trust and credibility. Findings from the evaluation suggest that the designed intervention was generally perceived as easy to use, with clear and relevant content. Although no conclusions can be drawn about the intervention's impact on behavior, it showed promise in promoting responsible supplement use and supporting better informed health decisions.

Keywords: digital health intervention, food supplements, informed decision-making, personalized health information

1 Introduction

The use of food supplements has become increasingly prevalent in recent years. A 2022 survey across 14 countries of the European Union (EU) reported that 88% of respondents had used a supplement at least once in their life [1]. Food supplements are products that contain concentrated vitamins, minerals, amino acids, herbal extracts, or other substances in specific dosages [2]. They are available in various forms, such as pills, capsules, or liquids, and can contain individual substances or combinations. In the Netherlands, the use of these products has also increased significantly over the past decades, rising from 17% supplement users in 1987/1988 to 57% in 2019-2021 [3] [4].

Despite their popularity, public health authorities do not recommend supplements for the general population. Instead, health institutions recommend supplementation only for specific risk groups. In the Netherlands, for example, vitamin D, vitamin B12, vitamin K, and folic acid are recommended for specific risk groups with an increased risk of deficiency [5]. For other healthy individuals without risk of deficiency, there is little to no evidence that food supplements offer any benefit [6]. However, this scientific consensus is not reflected in consumer behavior. Rather than being guided by evidence-based information, their decisions are often driven by personal beliefs [7] [8]. As a result, many people consume supplements without a clear understanding of their necessity or potential risks. Because inappropriate usage can lead to harmful consequences [9], better education or guidance for consumers seems necessary.

One promising way to address this issue is through digital communication tools, such as websites and mobile applications, which have been shown to improve health literacy [10]. Health literacy can be defined as the ability to find, understand, and apply health information in order to make informed health-related decisions [11]. Digital tools can function as interventions by guiding consumers towards better health decisions, ultimately contributing to better health outcomes [10]. To be effective, these tools must be carefully designed to ensure that they are accessible and understandable to users. In addition, a user-centered approach is essential to increase engagement with digital interventions [12].

This paper describes the development of a digital intervention that aims to inform consumers about supplements and promote responsible supplement use. Vitamins were selected as the focus of this study because they represent the most commonly used type of food supplement in the Netherlands [1] [4]. The development process was guided by the Centre for eHealth Research (CeHRes) Roadmap, a framework that offers a structured and user-centered approach for designing effective digital health technologies [13]. It integrates insights from psychology, communication science, and human–computer interaction to align technology and content with user needs. The framework also distinguishes itself by addressing aspects such as busi-

ness modeling and implementation strategies, although these were outside the scope of this study. The complete Roadmap consists of five iterative phases: contextual inquiry, value specification, design, operationalization, and summative evaluation (Figure 1). Each phase is designed to inform the next, with iterative cycles that allow for continuous reflection and adjustment. For this study, only the first three phases were conducted, although a small-scale formative evaluation was added to examine initial user experiences. The remainder of this paper presents the four phases of the development process in sequential order for clarity. For each phase, the methods and results are presented separately, with the methods illustrating how the development process proceeded and the results reflecting the key insights and decisions made during each phase.

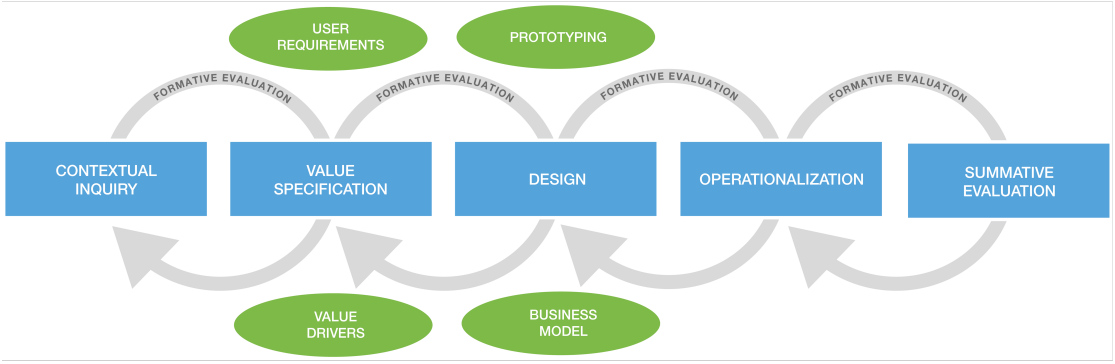

Figure 1: The five phases of the CeHRes Roadmap [13].

2 Contextual Inquiry

2.1 Method

The goal of the contextual inquiry was to gain an understanding of consumer needs and difficulties regarding vitamin supplement information. Although the CeHRes Roadmap encourages to involve users throughout the development process, this study follows a literature- and theory-driven approach, using existing user studies as the main source of information. This decision was based on two considerations. First, existing literature already provided sufficient data on consumer behavior and motivations regarding supplement use. Second, relying on existing evidence made the development process more feasible within the scope and time constraints of this study.

To gather the necessary insights, an exploratory literature review was conducted, focusing on general consumer motivations and behaviors around supplement use. Since many studies addressed dietary supplements in general rather than vitamins specifically, these were also included to broaden the available information and provide a more comprehensive understanding.

2.2 Results

2.2.1 Consumer Characteristics and Motivations

Consumption of vitamin supplements is more prevalent among certain demographic groups. In particular, women, older adults, and individuals with higher levels of education tend to use vitamin supplements [14] [15]. Supplement users are also more likely to engage in health-conscious behaviors, such as maintaining a balanced diet, exercising regularly, and managing a healthy weight [16] [17].

Notably, those who are most likely to use supplements are often not the people who need them [18] [19]. Supplement use is therefore not always driven by nutritional necessity, but instead is influenced by other motivational factors. A 2022 survey involving participants from 14 EU countries found that the top three reasons for use were to maintain overall health, support the immune system, and increase energy levels [1]. However, like most studies on this topic, it did not distinguish between different types of supplements, such as vitamins versus minerals. Other commonly reported motivations for general supplement use include compensating for perceived dietary deficiencies, preventing illness, and improving physical performance [8] [17] [20] [21]. Many of these motivations are driven by social influences, such as online trends and peer behavior, which contribute to the normalization of supplement use [8] [22].

2.2.2 Misunderstandings and Risks

Several issues have been reported about how consumers understand and use vitamin supplements. First of all, a common misperception is that supplements are inherently beneficial, regardless of whether supplementation is actually necessary [8]. However, taking supplements without a clear deficiency provides little to no health benefits [6]. In fact, only specific risk groups with an increased risk of deficiency are known to benefit from certain supplements [23]. Table 1 shows the main groups for whom supplementation is recommended according to Dutch guidelines.

Furthermore, supplement users often assume that supplements are safe and may be unaware of potential risks [7] [24]. For example, some consumers are unaware of recommended intake levels, and even believe that taking higher doses is more beneficial [25]. However, this assumption is incorrect. Consuming vitamins in high doses can lead to side effects and, in some cases, harmful health consequences [9]. In addition, some consumers may not realize that some vitamins can interact with prescription medications [24]. Such vitamin-drug interactions can influence the safety and effectiveness of medication by causing toxicity or reducing drug efficacy [26] [27]. Adverse health effects may also result from supplements interacting with other supplements [28].

Table 1: Groups for whom supplementation is recommended, based on advise from the Dutch Health Council [5].

Group	**Supplement**
Babies up to 3 months old, breastfed or receiving less than 500 ml formula per day	Vitamin K
Children aged 0–3 years	Vitamin D
Women trying to conceive	Folic acid
Women in the first 10 weeks of pregnancy	Folic acid
Pregnant women	Vitamin D
Dark-skinned people	Vitamin D
People with limited sun exposure	Vitamin D
Women aged 50–69 years	Vitamin D
Women and men aged 70 years and older	Vitamin D
Vegans	Vitamin B12

Other misunderstandings are caused by health claims, which consumers often misinterpret or overestimate [29]. In the EU, health claims for supplements must be scientifically evaluated by the European Food Safety Authority (EFSA) before they are permitted on packaging [30]. A second requirement is that such claims must be formulated in a way that is understandable to the average consumer. Nevertheless, many consumers misinterpret these claims, as their understanding is influenced by their own knowledge and beliefs [31]. Consequently, their interpretation and expectations of the associated health benefits may differ from the intended meaning of the claim.

2.2.3 Information Sources and Decision-Making

Supplement users obtain information about vitamin supplements from various sources. In the Netherlands, 33% obtain their information from doctors or medical professionals, 20% from the internet, 18% from friends or family, 15% from pharmacists, and 13% from retail sales staff [1]. While healthcare professionals are generally reliable sources, a significant proportion of consumers rely on informal or less regulated channels. For example, it remains unclear to what extent consumers rely on evidence-based information when turning to the internet, or whether they are influenced by unverified sources such as social media or commercial websites.

Another common source through which consumers receive information about supplements is the product label. Regulatory bodies such as the EFSA require manufacturers to disclose important information, including ingredients, recommended daily portions, safety warnings about excessive doses, and safety warnings for children [2]. Labels must also include a statement indicating that food supplements are

not intended to replace a varied diet. Additionally, labels are not allowed to include claims that a supplement prevents, treats, or cures diseases, in accordance with EU health claims legislation.

Even though these regulations ensure that essential product information is provided, product labels may have limited impact on consumer beliefs about the efficacy or safety of supplements. This is illustrated by the fact that while 85% of supplement users in the EU report reading product labels and 69% say they find them easy to understand, only 10% consider labels one of their main sources of information [1]. More importantly, these are self-reported figures and experimental studies show that in reality, a significant portion of consumers do not regularly read or fully comprehend supplement labels [32]. Comprehension of supplement labels can be hindered by several factors, including technical language, small font sizes, and inconsistent formatting. Although clearer and more standardized label designs may improve understanding, they usually do not lead to changes in behavior.

3 Value Specification

3.1 Method

In this phase, values and design requirements for the intervention were formulated. This started with an analysis of user insights from the contextual inquiry to identify the main problems the intervention should address. Based on these insights, key values were determined to define the main health communication principles the intervention should support, and specific design requirements were established to guide the design phase.

3.2 Results

The value specification resulted in three values: personalization, informed decision-making, and trust and credibility. **Personalization** aligns with the concept of tailored health communication, which involves adapting health information to make it more personally relevant and easier to understand [33]. In the context of vitamin supplements, tailoring information is particularly useful because nutritional needs and supplement risks vary between individuals. Tailoring has been shown to improve attention, recall, and message acceptance, and has a positive impact on health-related behaviors [34]. Common tailoring strategies include aligning content with an individual's specific needs, presenting it in a meaningful context, or delivering it in a preferred format [35]. For this study, personalization will focus on tailoring the content of supplement information.

Informed decision-making refers to making health-related choices based on understanding relevant information, available options, potential risks and benefits, and aligning the decision with one's personal values and preferences [36]. The concept originates from clinical contexts, where patients often have to decide between different treatment options in situations of uncertainty or risk. Digital health interventions that support informed decision-making have been shown to improve users' knowledge and risk perception [36] [37]. In the context of vitamin supplements, informed decision-making involves understanding of the supplement's effects, its necessity, available alternatives, and associated risks.

Trust and credibility refer to the perceived truthfulness and reliability of health information [38]. This plays an important role in whether users accept, remember, and act on the information provided [39]. This is important in the context of vitamin supplements, where misunderstandings are common. In web-based health communication, trust and credibility are influenced by both the information content and design features of a website [39]. Credible content is achieved through factors such as accuracy and quality of the information, as well as by ensuring that the information is easy to understand. Design features that support trust and credibility include a clear layout, interactive elements, and intuitive navigation.

The three values form the foundation for the design requirements of the intervention, which specify the types of information and functionalities that the intervention should offer. Table 2 presents these three values, along with the user insights identified during the contextual inquiry and the corresponding design requirements.

Table 2: The three identified values, with the key user insights identified during the contextual inquiry and the corresponding design requirements.

Value	User Insights	Design Requirements
Personalization	Supplement use not beneficial for everyone; needs vary based on personal factors; personal motivations for use	Tailor info to user profile; highlight relevance for individual needs or motivations;
Informed decision-making	Users overestimate benefits; unaware of needs/risks/dosages; misinterpret health claims.	Explain misconceptions; present dietary sources; inform users about dosages and risks; clarify effectiveness and evidence behind health claims
Trust & credibility	Info may come from non-credible sources; credible sources may be hard to understand	Info based on evidence and regulations (e.g. EFSA); provide understandable info with clear design

4 Design

4.1 Method

During the design phase, a functional web-based prototype was developed using Framer. Framer is a visual design and development tool for building interactive websites. This allowed for rapid prototyping and flexibility in adjusting the prototype's functionality and layout during the design process. Additional coding through React/JavaScript was used to implement more complex interactions and logic. The design was informed by the values identified in the value specification phase.

4.2 Results

The designed intervention is an interactive web-based interface that provides users with tailored, evidence-based information about vitamin supplements[1]. Three vitamins were selected to be included in the intervention: vitamin D, vitamin C, and vitamin B12. Vitamin D was chosen due to its status as the most commonly used supplement in the Netherlands and Europe [1]. Vitamin C was included for being the second most commonly used. Vitamin B ranked third, but since this vitamin includes several types, vitamin B12 was selected for its relevance to individuals following a vegan diet. The scope was limited to these three due to time constraints. The following sections describe how each value identified in the value specification phase is reflected in the design of the intervention.

4.2.1 Personalization

Personalization was achieved through a short, adaptive questionnaire that consists of closed-ended questions and determines which information is relevant to the user (Figure 2A). First, users are asked whether they are filling in the questionnaire on behalf of a child, which triggers child-specific adjustments in both the questions and the resulting information. Next, several questions are asked that identify factors known to influence vitamin needs, including age category, biological sex, skin tone, time spent in the sun, vegan diet, pregnancy, and breastfeeding status. Based on the collected input, the intervention determines whether the user falls within a risk group for vitamin deficiencies, as well as their adequate intake or recommended daily allowance. Additionally, the questionnaire includes a question about medication use to determine whether safety warnings about drug interactions are needed. To increase relevance further, the questionnaire dynamically adapts based on earlier responses. For example, questions about pregnancy and breastfeeding are only shown to women of reproductive age, for whom these topics are applicable.

[1] https://vitaminewijzer.framer.website

After completing the questionnaire, a brief message appears: "Just a moment – generating personalized information...". Although no actual loading time is required, this moment of pause is deliberately designed to reinforce the impression that the information is being actively and personally prepared. Ultimately, the collected input is used to tailor the presented information accordingly.

4.2.2 Informed desicion making

Informed decision-making was achieved by providing the user with balanced information rather than persuading them to take or avoid supplements. After completing the questionnaire, users are asked to select a vitamin they want to learn more about (Figure 2B). The information is then presented in four structured sections (Figure 2C), each supporting a different aspect of informed decision-making as defined earlier. The personalization functionality ensures that all information across these sections is relevant to the user.

1. The first section clarifies that supplementation is not necessary for everyone. It helps users understand their individual vitamin needs by indicating whether supplementation is recommended according to Dutch health guidelines. This section also provides personalized information by showing users their recommended intake level.

2. The second section addresses how users can meet their vitamin needs and encourages them to consider all available options, not just supplements. Users with a supplementation recommendation receive information about both the recommended supplement and dietary sources of that vitamin, while users without a recommendation are encouraged to focus on food as the primary source of nutrients (except for vitamin D, for which sunlight is the main source). An overview of foods high in the selected vitamin is provided, and a search bar allows users to look up specific food products and their vitamin content.

3. The third section helps users evaluate the potential benefits of vitamin supplements by presenting the most commonly cited reasons for use, including overall health, the immune system, and energy levels. These reasons are presented alongside other scientifically evaluated claims, with explanations of whether they are supported by scientific evidence. However, users are also informed that taking more than the recommended amount does not provide additional health benefits. The information in this section is personalized by showing users without a supplement recommendation a message to carefully consider their reasons for taking supplements to avoid unnecessary intake, while users with a recommendation are shown the specific reasons why the supplement is recommended.

4. The final section raises awareness of safety concerns and informs users about possible risks, including side effects of excessive intake, tolerable upper intake levels, and potential supplement interactions. In this section, personalization is functional by only showing warnings about drug interactions to users who indicated medication use in the questionnaire.

4.2.3 Trust and credibility

To achieve trust and credibility of the intervention, the information content and design features were intentionally designed. The information content aimed for accuracy and clarity, while the design features focused on a clear layout and ease of use. First, accuracy of information was ensured by basing it on multiple authoritative public sources:

- The Dutch Health Council provides official recommendations on supplement use, including which population groups are advised to take supplements and at what intake levels [40] [41]. This data was used to define user profiles and tailor the information accordingly. They also provide information on tolerable upper intake levels of vitamins, which help prevent overdoses.

- The Dutch National Institute for Public Health and the Environment (RIVM) provides nutritional data through the Dutch Food Composition Database (NEVO), which was used to build a search bar for the vitamin content of foods [42].

- Information about supplement effectiveness was based on evaluations conducted by the EFSA, with health claims authorized by the European Commission (EC) [43]. For the commonly cited reason "maintaining overall health," no specific claims have been evaluated. Therefore, users are informed that overall health is best supported through a balanced diet and a healthy lifestyle, according to Het Voedingscentrum [44]. For other claims that were not evaluated or not included in the intervention, the message either states that the claim has not been assessed or directs users to consult a healthcare professional.

- Additional background information on food sources, potential side effects, and the reasons why certain supplements are recommended for specific groups is based on information from Het Voedingscentrum [44]. Information on potential supplement-drug interactions is limited to warnings and a recommendation to consult a healthcare professional, as this required expertise that was not available for this study.

Furthermore, content was designed to be easy to understand for a broad audience. This was achieved by following plain language principles. Concise explanatory texts and consistent language were used throughout the intervention, and technical terms were avoided. Furthermore, progressive disclosure was applied to reveal information in stages, which helped reduce cognitive load.

In terms of design features, the goal was to create a clear and intuitive interface. The interface uses a layout with consistent visual elements, as well as a clear visual hierarchy and navigation structure. Several design choices were informed by Nielsen's usability heuristics [45]. For example, in the questionnaire, *visibility of system status* is supported by a progress indicator; *user control and freedom* is facilitated by allowing users to navigate back and forth between steps; and *help and documentation* is provided via a small information button for certain questions, providing additional context on how to answer them or the reason why they are being asked. In the information screens, *recognition rather than recall* is supported by using uniform layouts and consistent icons across all sections, making it easier for users to identify functions and content.

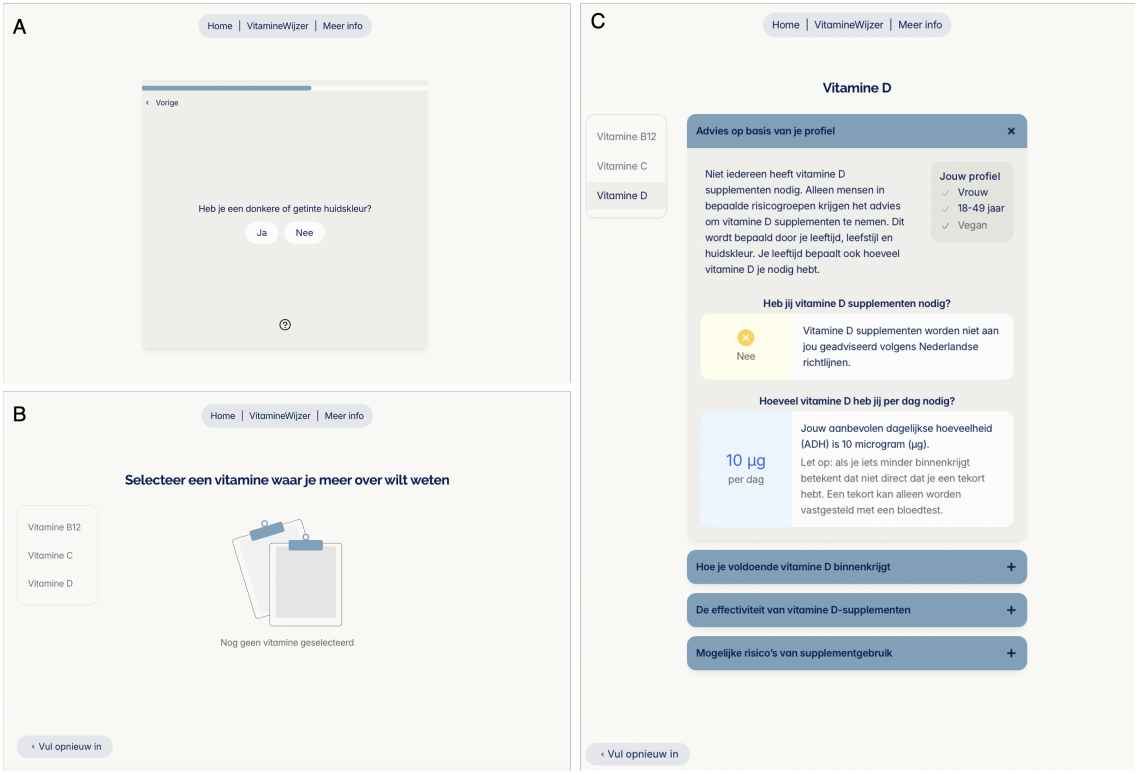

Figure 2: Three screens of the intervention: (**A**) the questionnaire users fill in to receive personalized information, (**B**) the screen shown after completing the questionnaire, before a specific vitamin is selected, and (**C**) the four collapsible information sections displayed once a vitamin has been selected.

5 Evaluation

5.1 Method

The aim of this formative user evaluation was to gather initial user experiences and opinions regarding the intervention, and identity possible directions for future improvement. Since the quality of the design can be assessed at different levels, the intervention was evaluated in terms of system quality and content quality. These evaluation dimensions are based on the DeLone and McLean Information Systems (IS) Success Model [46], following the approach described in the CeHRes Roadmap [13]. The model distinguishes three dimensions of quality. System quality concerns how user-friendly and easy to use a system is. Content quality focuses on the clarity, accuracy, and relevance of the information provided. Service quality, addresses how acceptable and feasible the digital service is in real-world use. This third dimension was not part of the current evaluation, as the prototype does not yet function as a fully implemented digital service.

A small-scale evaluation was conducted with five participants, recruited through convenience sampling, a sampling technique in which participants are chosen based on their ease of access and availability to the researcher. All participants were adults who had some basic familiarity with vitamin supplements, having either considered or used them at some point in their lives. Before the evaluation session started, participants were given a brief explanation of the study and asked to give their consent to participate in the user evaluation.

During the evaluation, participants were presented with a scenario and asked to explore the website. In order to create a natural and realistic user experience, they were encouraged to interact with it as they would in real life. During interaction with the prototype, observational notes were taken to capture moments of confusion or hesitation.

After completion of the task, a short semi-structured interview was conducted, focusing on three topics: ease of use, comprehensibility, and perceived personalization. These reflect the two main quality dimensions: system quality is reflected in participants' experiences with the ease of use of the interface, while content quality is represented by their perceptions of comprehensibility and personalization of the information provided. Each topic included both Likert scale questions (1–5) to clarify the strength of opinions, and open-ended questions for qualitative feedback. Due to the small sample size, Likert scores were averaged to provide a general overview but were not subjected to statistical analysis. Open-ended responses were summarized to identify common themes and suggestions. The full evaluation protocol is provided in Appendix A.

5.2 Results

The feedback of five participants is presented below, structured according to the two main quality dimensions: system quality (represented by ease of use) and content quality (represented by comprehensibility and perceived personalization).

5.2.1 System Quality: Ease of Use

Overall, participants found the prototype easy to use, with an average of 4.8. All participants were able to complete the questionnaire and access the content. Users consistently described the website as clear, well-structured, and visually appealing. They appreciated the layout, logical flow, and minimalist design, which contributed to a smooth navigation experience. Several participants highlighted the collapsible content sections as particularly effective for maintaining overview and accessing specific information quickly. However, one important issue was noted, which affected how participants understood the interface. Some participants initially thought all three vitamin were recommended for them, only realizing later that personalized advice was shown after clicking each option. They suggested using color or visual markers to highlight relevant vitamins and reduce confusion.

5.2.2 Content Quality: Comprehensibility

Participants rated the comprehensibility of both the questions and the information. The average score for the comprehensibility of the questions was 4.8 and the questions were described as clear and easy to understand. One participant suggested that the question regarding gender could benefit from an additional explanation, particularly to clarify why the question is being asked for users who identify outside the binary.

The average score for the comprehensibility of the information was 4.6 and the content was described as understandable, with clear language. Several users appreciated the segmented structure and collapsible blocks, as this made the information less overwhelming and provided a clear overview. Participants indicated that, although the search bar and list of food sources were helpful, translating portion sizes into practical amounts could be improved. A tool that allows users to input specific quantities of food and see the corresponding percentage of the recommended daily intake could address this issue.

5.2.3 Content Quality: Perceived Personalization

Perceptions of personalization were overall positive, with an average score of 4.6. Most participants felt that the information provided was relevant to their personal situation. The initial questionnaire played a key role in creating this impression,

as did the profile section summarizing their answers. However, as mentioned under ease of use, participants felt that the relevance of the different vitamins could be emphasized more clearly. This weakened the sense of personalization for them. Another participant commented that the tool asked about veganism but not about vegetarianism, which felt like a missing aspect of the personalization.

5.2.4 Other Implications

Some participants shared additional reflections about the potential impact of the website. Several noted that the website provided them with new insights. For example, one participant stated that they had not previously realized they belonged to a risk group for vitamin D. Another mentioned becoming more aware of the potential risks of taking excessive supplements or combining them with medication. Additionally, one participant suggested a way to enhance the website's impact. They recommended adding a reflective closing screen that invites users to indicate whether their opinion has changed or whether they are now considering using supplements to support more conscious decision-making.

6 Disscusion

6.1 Main Findings

This study described the development of a web-based intervention to inform consumers about vitamin supplements and promote responsible supplement use. The first three phases of the CeHRes Roadmap guided the development process. First, an exploratory literature review identified important user needs and led to the formulation of three values that the intervention should support: informed decision-making, personalization, and trust and credibility. These values formed the foundation of the intervention's specific design requirements and provided direction for the design process. Finally, a formative evaluation with five participants indicated that the designed intervention was generally perceived as easy to use, with content that was clear and relevant.

The three values reflect the main health communication principles the intervention should support. While they were defined individually, they are also closely related and influence one another. For example, besides personalization supporting relevance and engagement [47], it may also enhance trust [39]. At the same time, both tailored and trusted information are needed to enhance informed decision-making [48]. The mutual reinforcement of these values demonstrates the importance of incorporating them in interventions addressing health topics. Although this intervention effectively incorporated these values, improvements based on user feedback remain essential to fully realize their potential in practice.

Several insights on how these values could be further strengthened through design refinements were revealed in the formative evaluation. For example, some participants indicated that the relevance of individual vitamins was not immediately clear, which affected their perceived personalization and comprehension. Clarifying this could improve perceived personalization, potentially leading to improved decision-making and perceived trust. Another suggestion involved enhancing the food search bar to improve the comprehension of available options, thereby supporting informed decision-making.

6.2 Limitations and Future Work

As mentioned in the contextual inquiry, this study followed a theory-driven approach based on existing literature, rather than directly involving users to inform the development process. While this enabled a scalable and evidence-based design process, involving users, for example through co-design or interviews, might have revealed additional needs or perspectives. This is especially important given that many supplement users base their choices on personal beliefs or experiences rather than scientific evidence [7] [8]. Because the tool provides evidence-based information in line with official guidelines, it may not satisfy users who are primarily seeking confirmation of their pre-existing beliefs. Addressing every possible belief in this intervention is likely infeasible, yet other research offers examples of how such diversity in user perspectives could be approached. For example, in the United States, the integrated Dietary Supplement Knowledge base (iDISK) recently added a natural-language question-answering system, allowing users to pose open-ended questions and receive evidence-based responses about supplement ingredients and their links to related drugs, diseases, and products [49]. Such approaches could inform future iterations of the intervention to address a wider range of user perspectives.

Furthermore, the intervention's real-world impact remains unexplored. A website alone does not guarantee impact if users are unaware of its existence. Awareness campaigns could help bring the website to the attention of users who might not otherwise encounter it, for example via social media, pharmacies, health professionals, or other public health initiatives. However, even with increased visibility, a web-based intervention may not be sufficient to inform all consumers about the necessity or potential risks of food supplements, especially since some consumers do not actively seek information about them before purchase [50]. For these groups, alternative strategies may be more effective. An example is a point-of-sale communication campaign that delivered health messages at the moment of supplement purchase, which proved effective in raising awareness and encouraging consumers to seek more information or consult healthcare professionals [51].

While no conclusions can be drawn about behavior change for this intervention, previous research suggests that tailoring the content of health messages can positively influence health behaviors and outcomes [34]. This indicates that the current intervention, which applies content tailoring, has the potential to support behavior change and improve supplement-related health outcomes, however, further research is needed to confirm this. During the evaluation, one participant suggested adding a reflective closing screen prompting users to indicate whether their opinion had changed. For future iterations, such a feature could help provide an indication of whether the intervention impacts users' decisions or intended behaviors.

7 Conclusion

The use of vitamin supplements is widespread across various countries, yet often driven by personal beliefs rather than evidence-based information. This increases the risk of unnecessary or uninformed use. To address this, a digital intervention was developed to promote responsible supplement use by informing consumers about the necessity, efficacy, and safety of vitamin supplements. The resulting intervention was built around three main values: informed decision-making, personalization, and trust and credibility. A formative evaluation suggested that the designed intervention was generally perceived as easy to use, with content that was clear and relevant. The findings of this study illustrate how a digital intervention can be designed to support more responsible supplement use and contribute to better-informed health decisions. Future research should focus on refining the intervention based on user feedback and evaluating its impact on behavior over time.

References

[1] Ipsos, "Consumer survey on food supplements in the eu." `https://foodsupplementseurope.org/wp-content/uploads/2022/07/FSE-Consumer_Survey-Ipsos-2022.pdf`, 2022. Accessed on July 27, 2025.

[2] European Food Safety Authority (EFSA), "Food supplements." `https://efsa.europa.eu/en/topics/topic/food-supplements`. Accessed on July 27, 2025.

[3] E. Dorant, P. A. van den Brandt, A. M. Hamstra, M. H. Feenstra, R. A. Goldbohm, R. J. J. Hermus, and F. Sturmans, "The use of vitamins, minerals and other dietary supplements in the netherlands," *International Journal for Vitamin and Nutrition Research*, vol. 63, no. 1, pp. 4–10, 1993.

[4] C. van Rossum, E. Sanderman-Nawijn, HAM Brants, C. Dinnissen, and M. Jansen-van der Vliet, "The diet of the dutch. results of the dutch national food consumption survey 2019-2021 on food consumption and evaluation with dietary guidelines," 2023.

[5] Voedingscentrum, "Suppletieadviezen vitamines, mineralen en spoorelementen." https://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Professionals/Pers/Factsheets/Factsheet%20Suppletieadviezen%20vitamines%20mineralen%20en%20spoorelementen.pdf, n.d. Accessed on July 31, 2025.

[6] E. Guallar, S. Stranges, C. Mulrow, L. J. Appel, and E. R. Miller, "Enough is enough: Stop wasting money on vitamin and mineral supplements," *Annals of Internal Medicine*, vol. 159, p. 850–851, Dec. 2013.

[7] E. M. Pajor, A. Oenema, S. M. Eggers, and H. de Vries, "Exploring beliefs about dietary supplement use: focus group discussions with dutch adults," *Public Health Nutrition*, vol. 20, p. 2694–2705, Aug. 2017.

[8] F. Sirico, S. Miressi, C. Castaldo, R. Spera, S. Montagnani, F. Di Meglio, and D. Nurzynska, "Habits and beliefs related to food supplements: Results of a survey among italian students of different education fields and levels," *PLOS ONE*, vol. 13, p. e0191424, Jan. 2018.

[9] H. K. Biesalski and J. Tinz, "Multivitamin/mineral supplements: Rationale and safety – a systematic review," *Nutrition*, vol. 33, p. 76–82, Jan. 2017.

[10] P. J. Fitzpatrick, "Improving health literacy using the power of digital communications to achieve better health outcomes for patients and practitioners," *Frontiers in Digital Health*, vol. 5, Nov. 2023.

[11] Centers for Disease Control and Prevention (CDC), Office of Communications, "What is health literacy?." https://www.cdc.gov/healthliteracy/php/about/, Oct. 2024. Accessed on July 26, 2025.

[12] S. Michie, L. Yardley, R. West, K. Patrick, and F. Greaves, "Developing and evaluating digital interventions to promote behavior change in health and health care: Recommendations resulting from an international workshop," *Journal of Medical Internet Research*, vol. 19, p. e232, June 2017.

[13] J. E. van Gemert-Pijnen, N. Nijland, M. van Limburg, H. C. Ossebaard, S. M. Kelders, G. Eysenbach, and E. R. Seydel, "A holistic framework to improve the uptake and impact of ehealth technologies," *Journal of Medical Internet Research*, vol. 13, p. e111, Dec. 2011.

[14] S. Giammarioli, C. Boniglia, B. Carratù, M. Ciarrocchi, F. Chiarotti, M. Mosca, and E. Sanzini, "Use of food supplements and determinants of usage in a sample italian adult population," *Public Health Nutrition*, vol. 16, p. 1768–1781, Oct. 2012.

[15] P. Marques-Vidal, A. Pécoud, D. Hayoz, F. Paccaud, V. Mooser, G. Waeber, and P. Vollenweider, "Prevalence and characteristics of vitamin or dietary supplement users in lausanne, switzerland: the colaus study," *European Journal of Clinical Nutrition*, vol. 63, p. 273–281, Oct. 2007.

[16] K. Li, R. Kaaks, J. Linseisen, and S. Rohrmann, "Consistency of vitamin and/or mineral supplement use and demographic, lifestyle and health-status predictors: findings from the european prospective investigation into cancer and nutrition (epic)-heidelberg cohort," *British Journal of Nutrition*, vol. 104, p. 1058–1064, May 2010.

[17] A. Dickinson and D. MacKay, "Health habits and other characteristics of dietary supplement users: a review," *Nutrition Journal*, vol. 13, Feb. 2014.

[18] S. Kirk, A. Woodhouse, and M. Conner, "Beliefs, attitudes and behaviour in relation to supplement use in the uk women's cohort study (ukwcs)," in *Proceedings of the Nutrition Society*, vol. 57, p. 54A, 1998.

[19] C. d. R. Pavlak, M. Drehmer, and S. S. Mengue, "Dietary intake of micronutrients and use of vitamin and/or mineral supplements: Brazilian national food survey," *Nutrients*, vol. 16, p. 3815, Nov. 2024.

[20] I. Kovács, F. Liska, and Z. Veres, "Motivational drivers behind the consumption of dietary supplements by leisure-time athletes," *Foods*, vol. 12, p. 3044, Aug. 2023.

[21] A. Frey, I. Hoffmann, and T. Heuer, "Characterisation of vitamin and mineral supplement users differentiated according to their motives for using supplements: results of the german national nutrition monitoring (nemonit)," *Public Health Nutrition*, vol. 20, p. 2173–2182, June 2017.

[22] Z. Nábrádi, D. Bánáti, and Z. Szakály, "A study on consumer habits in the dietary supplements market," *Applied Studies in Agribusiness and Commerce*, vol. 14, p. 5–12, Dec. 2020.

[23] S. Rautiainen, J. E. Manson, A. H. Lichtenstein, and H. D. Sesso, "Dietary supplements and disease prevention — a global overview," *Nature Reviews Endocrinology*, vol. 12, p. 407–420, May 2016.

[24] T. Chiba and N. Tanemura, "Differences in the perception of dietary supplements between dietary supplement/medicine users and non-users," *Nutrients*, vol. 14, p. 4114, Oct. 2022.

[25] C. K. Miller, T. Russell, and G. Kissling, "Decision-making patterns for dietary supplement purchases among women aged 25 to 45 years," *Journal of the American Dietetic Association*, vol. 103, p. 1523–1526, Nov. 2003.

[26] A. L. Rogovik, S. Vohra, and R. D. Goldman, "Safety considerations and potential interactions of vitamins: Should vitamins be considered drugs?," *Annals of Pharmacotherapy*, vol. 44, p. 311–324, Dec. 2009.

[27] M. Lopes, M. A. Coimbra, M. d. C. Costa, and F. Ramos, "Food supplement vitamins, minerals, amino-acids, fatty acids, phenolic and alkaloid-based substances: An overview of their interaction with drugs," *Critical Reviews in Food Science and Nutrition*, vol. 63, p. 4106–4140, Nov. 2021.

[28] C. W. Binns, M. K. Lee, and A. H. Lee, "Problems and prospects: Public health regulation of dietary supplements," *Annual Review of Public Health*, vol. 39, p. 403–420, Apr. 2018.

[29] K. G. Grunert, J. Scholderer, and M. Rogeaux, "Determinants of consumer understanding of health claims," *Appetite*, vol. 56, p. 269–277, Apr. 2011.

[30] European Food Safety Authority (EFSA), "Health claims." `https://www.efsa.europa.eu/en/topics/topic/health-claims`. Accessed on July 27, 2025.

[31] A. P. Banks, B. Egan, C. E. Hodgkins, M. Peacock, and M. M. Raats, "The role of causal models and beliefs in interpreting health claims," *British Journal of Health Psychology*, vol. 23, p. 933–948, July 2018.

[32] H. Boon and N. Bozinovski, "A systematic narrative review of the evidence for labeling of natural health products and dietary supplements," *The Journal of Alternative and Complementary Medicine*, vol. 25, p. 777–788, Aug. 2019.

[33] H. de Vries and J. Brug, "Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach," *Patient Education and Counseling*, vol. 36, p. 99–105, Feb. 1999.

[34] M. L. A. Lustria, S. M. Noar, J. Cortese, S. K. Van Stee, R. L. Glueckauf, and J. Lee, "A meta-analysis of web-delivered tailored health behavior change interventions," *Journal of Health Communication*, vol. 18, p. 1039–1069, Sept. 2013.

[35] B. K. Rimer and M. W. Kreuter, "Advancing tailored health communication: A persuasion and message effects perspective," *Journal of Communication*, vol. 56, p. S184–S201, Aug. 2006.

[36] B. K. Rimer, P. A. Briss, P. K. Zeller, E. C. Chan, and S. H. Woolf, "Informed decision making: What is its role in cancer screening?," *Cancer*, vol. 101, no. S5, p. 1214–1228, 2004.

[37] D. Stacey, K. B. Lewis, M. Smith, M. Carley, R. Volk, E. E. Douglas, L. Pacheco-Brousseau, J. Finderup, J. Gunderson, M. J. Barry, C. L. Bennett, P. Bravo, K. Steffensen, A. Gogovor, I. D. Graham, S. E. Kelly, F. Légaré, H. Sondergaard, R. Thomson, L. Trenaman, and L. Trevena, "Decision aids for people facing health treatment or screening decisions," *Cochrane Database of Systematic Reviews*, vol. 2024, Jan. 2024.

[38] J. Liu, Y. Zhang, and Y. Kim, "Consumer health information quality, credibility, and trust: An analysis of definitions, measures, and conceptual dimensions," in *Proceedings of the 2023 Conference on Human Information Interaction and Retrieval*, CHIIR '23, p. 197–210, ACM, Mar. 2023.

[39] L. Sbaffi and J. Rowley, "Trust and credibility in web-based health information: A review and agenda for future research," *Journal of Medical Internet Research*, vol. 19, p. e218, June 2017.

[40] Gezondheidsraad, "Voedingsnormen voor vitamines en mineralen voor volwassenen," tech. rep., Gezondheidsraad, 2018.

[41] Gezondheidsraad, "Voedingsnormen voor vitamines en mineralen voor zuigelingen en kinderen," tech. rep., Gezondheidsraad, 2025.

[42] Rijksinstituut voor Volksgezondheid en Milieu (RIVM), "NEVO-online." `https://nevo-online.rivm.nl/`. Accessed on July 27, 2025.

[43] European Commision, "Food and Feed Information Portal Database." `https://ec.europa.eu/food/food-feed-portal/screen/health-claims/eu-register`. Accessed on July 27, 2025.

[44] VoedingscentrumVitamines, "Vitamines." `https://www.voedingscentrum.nl/`, n.d. Accessed on July 27, 2025.

[45] J. Nielsen, "10 usability heuristics for user interface design." `https://www.nngroup.com/articles/ten-usability-heuristics/`, 1994. Accessed 20 July 2025.

[46] W. H. Delone and E. R. McLean, "The delone and mclean model of information systems success: A ten-year update," *Journal of Management Information Systems*, vol. 19, p. 9–30, Apr. 2003.

[47] E. S. Smit, A. J. Linn, and J. C. van Weert, "Taking online computer-tailoring forward: The potential of tailoring the message frame and delivery mode of online health behaviour change interventions," *The European Health Psychologist*, vol. 17, no. 1, pp. 25–31, 2015.

[48] J. Okello, "Impact of information provision on decision-making," *International Journal of Economic Policy*, vol. 4, p. 40–52, Mar. 2024.

[49] Y. Hou, J. R. Bishop, H. Liu, and R. Zhang, "Improving dietary supplement information retrieval: Development of a retrieval-augmented generation system with large language models," *Journal of Medical Internet Research*, vol. 27, p. e67677, Mar. 2025.

[50] J. P. Nathan, E. Kudadjie-Gyamfi, L. Halberstam, and J. T. Wright, "Consumers' information-seeking behaviors on dietary supplements," *International Quarterly of Community Health Education*, vol. 40, p. 171–176, Sept. 2019.

[51] A. I. Perlman, D. G. Lebow, K. Raphael, A. Ali, and L. A. Simmons, "A point-of-sale communications campaign to provide consumers safety information on drug–dietary supplement interactions: A pilot study," *Health Communication*, vol. 28, p. 729–739, Oct. 2013.

A User Evaluation Plan

Objective

The goal of this user evaluation is to assess system quality and content quality of the prototype. Specifically, the evaluation focuses on usability, comprehensibility, and perceived personalization. The goal is to identify both strengths and areas for improvement in the current design.

Methodology

A small-scale evaluation will be conducted. Participants will interact with the intervention while basic observational notes are taken. This will be followed by a short semi-structured interview to understand their experience and perception.

Participants

A total of 5 participants will be recruited. Participants will be recruited through convenience sampling. Criteria:

- Adults (18+)
- Basic familiarity with vitamin supplements (e.g. has considered or used supplements)

Procedure

1. Introduction For my thesis, I have worked on developing a website that provides science-based information about vitamin supplements. Today we will be testing the final prototype. The goal of this evaluation is to understand how people interact with the website and to understand what works well and what could be improved. I am interested in your honest thoughts and impressions.

With your permission, I will take some notes as you use the website and ask you a few questions afterwards. Your responses will be anonymous and used for research purposes only. Do you agree to participate in this study?

2. Task execution Scenario: "Imagine that you are unsure whether you need a vitamin supplement. Use the tool as you normally would to find out which vitamins might be relevant to your situation and explore any further information that you find useful."

3. Interview questions

Ease of use

- How would you describe your overall experience using the website?
- How easy or difficult was it to navigate the website?

  (1 = Very difficult, 2 = Difficult, 3 = Neutral, 4 = Easy, 5 = Very easy)
- Was there any moment where you didn't know what to do?

Comprehensibility

- How clear were the questions asked by the website?

  (1 = Very unclear, 2 = Unclear, 3 = Neutral, 4 = Clear, 5 = Very clear)
- How clear was the information about vitamin supplements provided to you?

  (1 = Very unclear, 2 = Unclear, 3 = Neutral, 4 = Clear, 5 = Very clear)
- Was any part confusing, unclear, or difficult to understand? If so, which parts?

Perceived personalization

- How relevant did you find the information you received for your personal situation?

  (1 = Very irrelevant, 2 = Irrelevant, 3 = Neutral, 4 = Relevant, 5 = Very relevant)
- What aspects made the website feel personalized or not personalized to you?
- Did the personalized information affect how helpful you found the website?

General comments

- Were there any features or parts of the website that you particularly liked or disliked?
- Is there anything you would change or improve?
- Do you have any other feedback or comments that you would like to share?