

Food supplements: Exploring our reasons for taking them



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Date: November 2022

Foreword

Food supplements contain vitamins and minerals in a concentrated form. They are designed to correct nutritional deficiencies but not designed to replace a healthy, balanced diet. The European Union definition of a “food supplement” is “foodstuffs the purpose of which is to supplement the normal diet and which are concentrated sources of nutrients [vitamins or minerals] or other substances with a nutritional or physiological effect, alone or in combination, marketed in dose form, namely forms such as capsules, pastilles, tablets, pills and other similar forms, sachets of powder, ampoules of liquids, drop dispensing bottles, and other similar forms of liquids and powders designed to be taken in measured small unit quantities” (Directive 2002/46/EC of the European Parliament and of the Council of 10 June 2002).

Dietary surveys have shown that most people are getting enough vitamins and minerals from their diet. Previous studies have shown that between 20 to 50 per cent of the population on the island of Ireland are taking food supplements (depending on gender and age group). This contrasts with current healthy eating guidelines, which promote a "food first" approach providing food-based recommendations to achieve an adequate diet without the need for additional supplementation within a healthy adult population. This research was commissioned by **safefood** to investigate why adults on the island of Ireland are taking food supplements or giving children or teenagers food supplements, to help inform guidance to the public.

Acknowledgements

safefood gratefully acknowledge the contributions of a range of organisations and individuals in the preparation of this report:

- The research team – Dr Kirsty Pourshahidi, Dr Liz Simpson, Dr Mary Slevin, Dr Maeve Kerr, Dr Catherine Hughes, Dr Pamela Magee and Dr Julie Sittlington from Ulster University, Coleraine
- Glenn Hall and Jenny Gilgunn (Cognisense Ltd, Belfast) for their expertise in quantitative data collection and fieldwork
- Nutrition interns and research students, Nutrition Innovation Centre for Food and Health, Ulster University, who supported online methodologies
- The community centre managers, staff and volunteers across the island of Ireland who graciously provided time and assistance in facilitating the recruitment and data collection processes
- All participants in the research

Executive summary

Aim and objectives

The aim of this research project was to explore why adults on the island of Ireland may or may not choose to take a food supplement, employing the Theory of Planned Behaviour to gain a better understanding of the personal, social and psychological factors that influence food supplements use in an adult population.

The objectives were to

- Conduct a literature review of existing available data on food supplements use and associated factors from within the island of Ireland and internationally
- Gain a better understanding of the personal, social and psychological factors that influence food supplements use in an adult population, employing the Theory of Planned Behaviour to define and measure these factors
- Explore behaviours, beliefs, attitudes, knowledge and awareness of risk or safety in relation to food supplements among adults on the island of Ireland, identifying factors that motivate and predict food supplements use *behaviour* and *intentions*

Methods

A mixed study methods approach was used including

- A review of relevant literature – that is, published scientific research.
- A desk-based audit, or survey, of a sample of 13 newsletters from the French Agency for Food, Environmental and Occupational Health and Safety’s Nutriviligilance scheme. (“Nutriviligilance” refers to any system that aims to improve consumer safety by rapidly identifying and reporting possible adverse effects, such as rashes, headaches, stomach pain and so on, associated with the consumption of foods, including food supplements.)
- Two stages of data collection and analysis to obtain a comprehensive understanding of food supplements use in adults on the island of Ireland. The results of the literature review were used to inform, or develop:
 - A qualitative elicitation study in the form of 4 online focus groups, made up of 39 participants in total. (An “elicitation” study aims to draw out information that is not directly countable such as emotions and perceptions – the “qualitative” data.)
 - A quantitative study in the form of a cross-sectional, representative survey of 2,000 people. (“Quantitative” information is directly countable or measurable. A “cross-sectional” study captures data about a population from a single point in time.)

The Theory of Planned Behaviour was used to define and measure factors that influence food supplements use behaviour and intentions.

Key findings

Literature review

Food supplements play an important role in correcting nutritional deficiencies, maintaining an adequate intake of certain nutrients and supporting specific physiological (bodily) functions. In the United Kingdom and Ireland, current public health guidelines focus on food-based recommendations and only advocate (advise and support) the use of food supplements in specific circumstances (such as in pregnancy or during the winter months). Despite this, there is growing evidence of the widespread use of food supplements across the population, with dietary surveys from Ireland and the United Kingdom recording that 20 to 50 per cent of adults report regularly taking food supplements (depending on gender and age group and often increasing with age).

The regulation of food supplements poses a significant challenge due to the nature and diversity of the market, and there are growing fears over the potential risk of excess micronutrient intakes, particularly among vulnerable groups such as older adults and children. There is also concern that the population may view supplements use as a substitute for eating a healthy diet. The aim of the review was to critically analyse current evidence investigating consumer knowledge, attitudes and behaviours and to examine issues in relation to the safe and appropriate use of food supplements.

Systematic literature searches identified 36 relevant studies that were included in the review. Observational evidence (simply data collected from observing a study sample that is behaving naturally or that is self-reporting on its everyday behaviour) has identified key characteristics of supplement users, with higher reported use among females, older adults and those from a more advantaged socioeconomic (social and economic) background. Furthermore, the reasons for taking food supplements are often multifactorial with “general health improvement” being a common motivation. It is evident that food supplements are generally perceived as “low risk” by the people who take them. This review highlights the need for future work to increase consumer knowledge around the safe and appropriate use of food supplements for example, checking whether a supplement is truly necessary or beneficial for health, only taking the correct dose, and checking whether supplements are safe to use when also taking medications. The provision of targeted nutritional supplementation use advice is warranted.

Audit of a sample of the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance newsletters (number 59 August 2019 to number 71 August 2020)

The audit of a sample of 13 newsletters from the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance scheme provided an evidence-based insight into clinical cases of adverse events associated with the consumption of food supplements and other food products. During the timeframe of the audit, 170 adverse event cases were recorded (on average, approx. 13 per month), and two-thirds of these were classified as likely or very likely that the product direct caused the adverse event. Cases of adverse events were reported across a wide age range of adults (18-90yrs) with approx. 10% reported in children and often in children <5yrs. Varying degrees of severity of adverse events were noted, spanning many different bodily systems and conditions. Most common were gastrointestinal, allergic, hepatic and cardiovascular-related symptoms.

Findings from qualitative focus groups and quantitative survey

Behaviours

- In the quantitative survey, almost half of the adults on the island of Ireland reported that they currently take food supplements (48 per cent).
- A significantly higher proportion of food supplements users were female, aged from 35 to 49 years, from Ireland, with a more advantaged socioeconomic background, working full-time, married or living as married, living with a diagnosed physical health condition, vegetarian or vegan.
- Among people who reported that they currently take food supplements, the mean or average number of supplements reported was 2.6 with a standard deviation (variation from the mean value) 1.7 above or below this number (on a range from 1 to 12 supplements used):
 - More than half of this group (60 per cent) were taking at least 1 food supplement (Vitamin D).
 - The top 3 food supplements reported by current users were vitamin D (60 per cent), multi- vitamin or mineral (41 per cent) and vitamin C (34 per cent). (Vitamins are any of a group of organic compounds which are essential for normal growth and nutrition and are required in small quantities in the diet because they cannot be synthesized by the body. Minerals are substances that occur naturally in the earth, for example calcium, iron, magnesium.)
 - The majority reported daily use of food supplements (81 per cent).
 - Nearly a quarter (24 per cent) of current food supplement users had been taking a supplement for the last 6 months.
 - The majority of current users bought the supplements themselves (87 per cent).

- Food supplements were most likely to be bought from a chemist or pharmacy (37 per cent).
- Nearly half of all parents or those with children in their care (47 per cent) among the survey respondents reported currently giving food supplements to their child or children.
- Parents, or those with children in their care, who were food supplements users themselves were 2.4 times more likely to give their child or children food supplements than parents who were not food supplement users.

Beliefs and attitudes

- The top 3 forms of food supplements commonly referred to during focus group discussions were “tablets or capsules”, “sachets or powders” and “shakes or drinks”.
- The terms “vitamin(s)” and “multivitamin(s)” were used by many people to mean any type of food supplement.
- Qualitative data from focus groups suggested that adults:
 - Mainly held positive attitudes towards food supplements
 - Are commonly influenced by healthcare professionals, family or other food supplements users
 - Could identify more facilitators than barriers to the use of food supplements

Knowledge and awareness of risk and safety in relation to food supplements

- Although there was better knowledge about food supplements among those who used them as against those who did not (mean, or average "knowledge" score of 2.64 as against 2.36, out of a possible score of 6), the difference was marginal and scores were low overall.
- The level of consideration and thought given to the use of food supplements was high, with more than two thirds agreeing or strongly agreeing that they
 - “Think carefully” about taking more than 1 supplement at a time
 - “Think carefully” about taking supplements at the same time as taking medication
 - “Always” check the correct dosage.
- Around 2 out of 5 adults perceived food supplements use to be “risk free” (37 per cent).
- A small proportion (around 5 to 10 per cent) of respondents do not think carefully about taking more than 1 food supplement at a time or with medications, or do not check the correct dose.

Predictors of behaviour and intentions

- The major determinants of *behaviour* (that is, use of food supplements) were being female, with higher socioeconomic status and having more positive intentions or attitudes towards supplements and their use.
- *Intentions* towards food supplements use (in the next month) increases among females, younger adults, those with higher socioeconomic status, and those with more favourable pre-

existing attitudes towards food supplements, higher subjective norms (more influencers/social pressure), more perceived behavioural control (a person's belief in their ability to act or to change their environment) and more social pressure towards undertaking the behaviour.

- Perceived health status was not associated with food supplements use or with the intention to use supplements.

Recommendations

Education

- Given the increasing proportion of the adult population reporting food supplements use (increased compared to previous estimates), more consumer education is needed to
 - Ensure consumer choice and behaviour is better aligned with the specific food supplements included in dietary guidance or recommendations
 - Increase the awareness of risks as against benefits
 - Ensure appropriate food supplement use.
- Education (for example continuing professional development, online training courses / webinars, resources distributed to key point-of-care groups, through professional bodies) for all healthcare professionals will help to ensure current public health messages are supported at the point of care.
- Updated guidance should be provided at common points-of-sale for food supplements (for example in pharmacies or on supermarket shelf-edges) to better inform consumers.
- Development of a reputable online resource by relevant public health bodies that would become the “norm” for those looking to obtain accurate and reliable information on food supplements would be desirable.

Public health communications

- Targeted public health campaigns on food supplements should
 - Promote clear and consistent messaging to consumers about food supplements use
 - Make clear what food supplements are specified in public health policy
 - Give hints and tips to help consumers get into the habit of only taking food supplements that are needed
 - Support consumers in making lower-cost choices when required e.g. signposting to less expensive own-brand products
- Information on the **safefood** website should be updated, for example with an infographic of project findings, supporting current advice for food supplements use across the lifecycle.

Monitoring and surveillance

- Food supplements use on the island of Ireland should be monitored in the long term to assess changes in consumer behaviour over time in the context of current Government guidelines and to inform future public health policy.
- An accessible system for identifying, reporting and monitoring of suspected adverse events, such as allergic reactions and poisonings, related to the use of food supplements is warranted to contribute to improved knowledge of food supplements and consumer safety.

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1 Introduction

Food supplements (concentrated forms of vitamins, minerals – substances that occur naturally in the earth, for example calcium, iron, magnesium – and other substances) are intended to correct nutritional deficiencies, maintain an adequate intake of certain nutrients and support specific physiological (bodily) functions. In Ireland and the United Kingdom (UK), healthy eating guidelines (1, 2) provide food-based recommendations to promote the best nutrient intake without the need for additional supplementation. Getting the ideal nutrient intake through eating a healthy, balanced diet is helped by the mandatory (that is, compulsory or required) “fortification” of flour with calcium, iron, niacin and thiamine, and in part by voluntary fortification of foods with B vitamins (including B12 and folic acid) and vitamin D. (“Fortification” means making food more nutrient-dense, or “stronger”, or by adding nutrients to the ingredients.) Women planning a pregnancy are further recommended to consume a 400-microgram (μg) supplement of folic acid per day, and the general population are advised to consume a 5- to 15-microgram supplement of vitamin D per day in winter months (3, 4).

With these exceptions, national dietary guidance does not promote the general use of food supplements. This is due to the potential risk of excess micronutrient intakes, particularly among vulnerable groups (such as older adults and children), and because of concerns that the population may view food supplements as a substitute for a healthy diet. The best strategy is to promote positive dietary change, for example increasing fruit and vegetable intakes and / or the consumption of fortified foods. However, recent UK data show that females and younger adults are particularly vulnerable to micronutrient shortfalls (including calcium, B vitamins and vitamin D) from food sources alone (5), suggesting that compliance to healthy eating advice is low. Furthermore, a high prevalence (the level or extent of occurrence) of low vitamin B12 and folate status has been reported recently among a representative sample of older adults in Ireland, suggesting that voluntary food fortification with these key nutrients is ineffective (6). Consumption of fortified foods has recently been reported as a key strategy to improve intakes of vitamin D and iron in preschool children in Ireland, along with food supplements use (7).

The 2 most common reasons for food supplements use among adults in the United States of America (US or USA) are reported to be to “improve” (45 per cent) or “maintain” (33 per cent) overall health. Older US adults (60 years and above) are more likely than younger US adults to

report motivations related to heart, bone and eye health. Also, these food supplements users from the US are more likely to report “very good” or “excellent” health and to have generally healthier lifestyles than non-users; for example, they exercise more frequently and are nonsmokers (8). Interestingly, 80 per cent of the US population are reported to be aware that food supplements should not be used to replace healthy diet or lifestyle habits (9).

Dietary surveys(2, 10) across Ireland and the UK have found that at least 20 per cent of children and younger adults and around 40 per cent of older adults report regular food supplements use. This suggests a noticeable difference between dietary recommendations relating to food supplements use and *actual* use of supplements, the reasons for which remain unclear. In addition, there are reported micronutrient shortfalls across the population, which may also indicate a difference between reported food supplements use and behaviour.

2 Aim and objectives

The aim of this project was to explore why adults on the island of Ireland may or may not take food supplements. The project employed the Theory of Planned Behaviour to gain a better understanding of the personal, social and psychological factors that influence food supplements use by adults.

The key objectives of this project were to

- Conduct a literature review of existing available data on food supplements use and associated factors from within the island of Ireland and internationally
- Gain a better understanding of the personal, social and psychological factors that influence food supplements use in an adult population, employing the Theory of Planned Behaviour to gain a better understanding and to define and measure these factors
- Explore behaviours, beliefs, attitudes, knowledge and awareness of risk or safety in relation to food supplements use among adults on the island of Ireland, identifying factors that motivate and predict food supplements use behaviour and intentions.

3 Methods

Introduction

This project used a mixed study methods approach including

- A review of relevant literature – that is, published scientific research.
- A desk-based audit, or survey, of a sample of 13 newsletters from the French Agency for Food, Environmental and Occupational Health and Safety's nutrивigilance scheme. (“Nutrивigilance” refers to any system that aims to improve consumer safety by rapidly identifying and reporting possible adverse effects, such as allergic reactions and poisonings, associated with the consumption of foods, including food supplements.)
- 2 stages of data collection to obtain a comprehensive understanding of food supplements use in adults from the island of Ireland. The results of the literature review were used to inform, or develop:
 - A qualitative elicitation study in the form of 4 focus groups, made up of 39 participants in total. (An “elicitation” study aims to draw out information that is not directly countable such as emotions and perceptions – the “qualitative” data.)
 - A quantitative study in the form of a cross-sectional, representative survey of 2,000 people. (“Quantitative” information is directly countable or measurable. A “cross-sectional” study captures data about a population from a single point in time.) The survey questionnaire was developed from the results of the focus group discussions.

The Theory of Planned Behaviour was used to define and measure factors that influence food supplements use behaviour and intentions.

Literature review

A review of the published scientific literature was used to identify existing data available from island of Ireland and internationally, exploring behaviours, beliefs, attitudes, knowledge and awareness of risk or safety relating to food supplements use among adults and (when applicable) children or teenagers in their care. The search protocol (that is, the search system and its rules) was developed, and used in Ovid® MEDLINE® online database, using recommended “Medical Subject Headings” terms (Table 1). (The US National Library of Medicine’s “Medical Subject Headings” is a controlled set of vocabulary used for the indexing, cataloguing and searching of biomedical and health-related information.)

Table 1 Search protocol for literature review in a study exploring food supplements use on the island of Ireland and internationally

Search concept terms	Alternative or shortened terms
dietary supplements/ or prebiotics/ or probiotics/	(nutrition* supplement* or diet* supplement* or vitamin* or multivitamin* or multi-vitamin)
Health behaviour/	(reason* or attitude* or motive* or knowledge or choice* or choose*)

Search terms were mapped to the database using these words, terms and phrases in this order of priority: mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms.

Results were limited to those studies published from 2010 onwards, about humans, in the English language and with full text available. A total of 1,186 results were reviewed for relevance, and key evidence was identified in 36 studies. Additional information was also sourced from the Food Standards Agency's (FSA) recent "Food Supplements Consumer Research" report (2018) (11) and nationally representative dietary surveys from the UK and Ireland(10, 12).

The literature review was used to inform, or develop, the qualitative and quantitative studies.

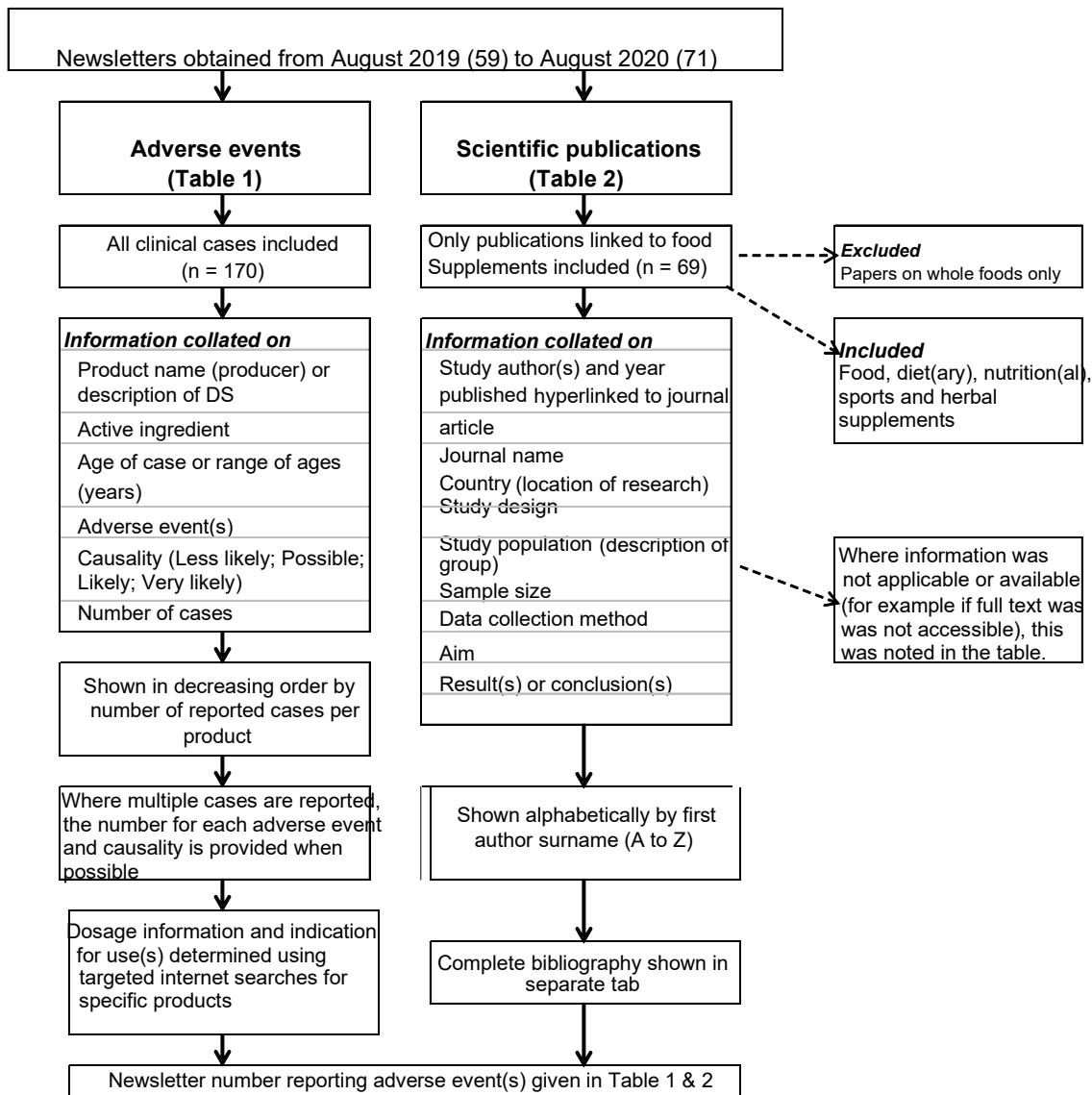
Audit of sample of the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance newsletters

Additional desk-based work included an audit of the information reported in newsletters produced from the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance scheme in France (13). Researchers obtained 13 monthly newsletters, published between August 2019 and August 2020 (number 59 August 2019 to number 71 August 2020). Each newsletter reported the clinical cases of adverse events linked to food supplements, novel foods, fortified foods and energy drinks.

Information was collated (collected and organised) for all cases: the product name (producer) or description, main active ingredients, age or age range of case (or cases), the specific adverse event, causality (the relationship between cause and effect – whether it is less likely, possible, likely or very likely that something was the cause of the adverse event) and the number of cases.

Scientific publications cited within each newsletter were also collated, summarising the research design, country and number of subjects (where relevant), as well as bibliographic details. The protocol for the collation is shown in Figure 1.

Figure 1. The protocol for the collation of a sample of the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance newsletters (number 59 August 2019 to number 71 August 2020) in a study exploring food supplements use.



Study design

Using the Theory of Planned Behaviour

The “Theory of Planned Behaviour” (14) was used to examine the factors influencing adults’ intentions to use food supplements and to gain a better understanding of the use of food supplements in a sample of adults from the island of Ireland . Exploring attitudes and beliefs about people’s consumption of food supplements provides a better understanding of variations in consumption patterns, which has not been widely studied within a theoretical framework. Strategies aimed at changing attitudes and, ultimately, behaviour are more effective when guided by theory (15). The Theory of Planned Behaviour enhances understanding of health behaviours and underlying cognitive (mental, learned, or thought-out) decision-making processes (16).

Intentions to perform a behaviour are closely linked to actual *behaviour*, and these intentions are influenced by 3 factors, or constructs:

- Attitudes
- Subjective norms (behaviours or ideas that are considered normal or usual according to a person’s belief or opinion)
- Perceived behavioural control (a person’s belief in their ability to act or to change their environment)

Attitudes to the behaviour – in this case, food supplements use – include the perceived benefits or risks of engaging in the behaviour. *Subjective norms* are the influence of important others such as family or friends in a person’s decision to engage with a behaviour. *Perceived behavioural control* is the belief about how easy or difficult it is to engage with the behaviour.

A consistent approach to the measurement of these constructs enables the Theory of Planned Behaviour to explain or account for variation in intentions to use food supplements and has been used in a small number of studies in adult females, pregnant mothers and Dutch adults (17-20). Moreover, this method has been endorsed by the National Institute for Health and Care Excellence (21) as an evidence-based method of predicting health-related behaviours.

Ethical approval was granted from the School of Biomedical Sciences Research Ethics Filter Committee at Ulster University (project ref: FCBMS/19/092).

Pilot online questionnaire

A pilot (trial) questionnaire was developed, informed by the literature review. The 41-item pilot questionnaire was organised into 5 distinct parts to assess the study participants'

- Demographics (personal and social information such as age, education, health status)
- Knowledge
- Attitudes
- Awareness of risk and safety
- Behaviours

in relation to food supplements use.

A range of question types were included; for example, "True / False / Don't know", Likert scales (a type of scale that measures levels of agreement with a statement), attitudinal scales (which measure the intensity of agreement or disagreement and are meant to reveal social norms or values), "open-ended" questions (which require a descriptive answer or allow for more than one answer) and "closed" questions (that only allow for 2 options, often "Yes / No").

The 6-item "knowledge" question was adapted by a previously validated (tried and trusted) questionnaire for the general public (22) but avoided questions on specific nutrients.

A 4-item question related to "awareness" of risk or safety in relation to food supplements use, and the list for sources of information, were both adapted from similar questions used previously (11, 23, 24).

The pilot questionnaire was administered online using REDCap® software (Research Electronic Data Capture [REDCap], Vanderbilt University Medical Center, Nashville, Tennessee, USA) from 3 to 24 August 2020. Respondents were invited to take part if they were 18 years of age or above and living on the island of Ireland. Participants were recruited through the Nutrition Innovation Centre for Food and Health at Ulster University, social media channels (Facebook®, Twitter® and Instagram®) and within community-based organisations from both Ireland and Northern Ireland (by direct email and social media).

Data collection was fully anonymous, and participants were advised that by completing the questionnaire they were giving consent for their data to be used for the purposes of the study.

A total of 146 completed responses were received. Quantitative data were analysed using IBM® SPSS Statistics® software version 25 (International Business Machines [IBM] Statistical Package for Social Science [SPSS], IBM, Armonk, New York, USA) and "open" or qualitative (descriptive) responses were coded and summarised using Microsoft® Excel® (Microsoft Corporation,

Albuquerque, New Mexico, USA). These results were used to inform the development of some questions within the quantitative survey. Specifically, Cronbach's alphas (the "α" value, measuring "internal reliability", or the consistency in the results of the questioning process) for the "knowledge" and "awareness of risk or safety" items were 0.52 and 0.61, respectively, suggesting they were appropriate to use in the larger quantitative survey.

Responses related to food supplements use behaviours also allowed refinement of the response options provided, for example categories listed for frequency or duration of use. Questions that were not directly used as given in the pilot questionnaire were those that were later captured by items included within the Theory of Planned Behaviour questions.

Qualitative elicitation study – Focus groups

Participants

Adults from both Northern Ireland and Ireland were recruited from among those that responded to the online pilot questionnaire and gave their permission to be recontacted, as well as by word of mouth. Males and females (18 years and above; 8 to 10 people per group) were included, and both current food supplements users and non-users were invited to take part.

All participants provided written informed consent using an online form, and sociodemographic variables, including knowledge and use of dietary supplements, were collected before each focus group (using REDCap® software).

Participants received an honorarium to the value of £20 (in Northern Ireland) or €25 (Ireland) for their time upon successful completion of the focus group.

Measures and procedures

Four online focus groups were conducted using Microsoft® Teams® (Microsoft Corporation, Albuquerque, New Mexico, USA) to gather rich (complex, detailed) qualitative data on participants' beliefs, attitudes and knowledge on food supplements use. Researchers also aimed to deepen their understanding of the rationale (the motivation, logic or principles) for the most common reasons adults choose to take (or barriers to why they do not take) food supplements and ascertain drivers for change behind such motivations or barriers.

A standard discussion guide was used in each focus group, containing a series of open-ended questions in keeping with recommended Theory of Planned Behaviour protocols (25). This guide was structured around the main constructs within the Theory of Planned Behaviour: attitudes to food supplements, subjective norms and perceived behavioural control. A summary of the guide

is shown in Table 2. (The full discussion guide is included in Appendix 1.) At the same point in each group, participants were shown a standard definition of food supplements(26) to facilitate more relevant and open discussions.

Table 2 Summary of focus group discussion guide for a qualitative elicitation study exploring food supplements use in adults on the island of Ireland

Introduction	Explain objective and ground rules. Ice-breaker (for example, name and location).
Opening topics	What is your understanding of food supplements? Explore current behaviours of the group regarding food supplements. Intentions – Change behaviour in the next month?
Definition	Read out standard definition of food supplements shown on screen. <ul style="list-style-type: none"> • Any thoughts or opinions?
Theory of Planned Behaviour constructs	<u>Attitudes</u> <ul style="list-style-type: none"> • What do you believe are the advantages and disadvantages of taking supplements? • Anything else you associate with your own views about taking supplements? <u>Subjective norms (social influences)</u> <ul style="list-style-type: none"> • Are there any individual or groups who would approve or disapprove of you taking supplements? • Anything else you associate with other people's views about taking supplements? <u>Perceived behavioural control (barriers or facilitators)</u> <ul style="list-style-type: none"> • What factors or circumstances would enable you or make it difficult or impossible for you to take supplements? • Any other issues that come to mind when you think about taking supplements?
Closing	Any other comments, views or opinions?

Each group was moderated (run and monitored) by the same experienced researcher (Dr Kirsty Pourshahidi), with an additional researcher present as an observer and note-taker (Dr Mary Slevin). The moderator used the discussion guide as a broad set of guidelines or issues to be covered during each session. Several facilitating and projective techniques (for example, asking probing questions or employing additional prompts) were used to enable groups to express their opinion or analyse their feelings. Discussions varied in length from 56 minutes to 1 hour 4 minutes, were video- and audio-recorded and transcribed (typed out) word for word.

Data analyses

Transcripts were subjected to thematic content analysis to identify, analyse and report themes within data (27). In line with the procedures for thematic analysis, the transcripts were read

several times to ensure familiarity with the themes and initial observations noted. Patterns in the data were identified and codes for these were established and then refined. The themes were named and assigned to their corresponding Theory of Planned Behaviour constructs. Analysis was conducted independently by 2 researchers (Dr Kirsty Pourshahidi and Dr Mary Slevin) to check reliability of themes and their relationships (28).

The most commonly reported themes from the focus groups were used to form the basis of a quantitative survey questionnaire assessing predictors of food supplements use in adults from the island of Ireland.

Quantitative study – Survey questionnaire

Participants

The survey questions were included within Cognisense's (market research company, Belfast) omnibus survey in Northern Ireland and Ireland to achieve a large, robust (strong and valid) and fully representative sample of the island of Ireland population. (An “omnibus survey” is a method of conducting quantitative market research where data on a wide variety of subjects is collected in the same interview on behalf of multiple businesses or organisations.) Cognisense's omnibus survey is conducted monthly in both Northern Ireland and Ireland, each comprising a representative sample of 1,000 adults sampled from actively managed panel partners (Dynata, with headquarters in Shelton, Connecticut, US; and Populus Ltd, London). Thus, a final dataset was available of 2,000 adults (males and females, 18 years and above) from the island of Ireland.

In both Northern Ireland and Ireland, the online omnibus survey “oversampled” beyond the target to ensure that each of the demographic “cohort” (subgroup) targets were broadly representative. After survey data collection, a “weighting” variable was applied to the data to ensure the final data was representative of national statistics for age, gender, socioeconomic status and geographic area for the island of Ireland as a whole. (“Weighting” of data is applied when the study sample is representing the whole population. “Unweighted” data is simply unaltered information gathered from the study sample.)

The cohorts were

- People aged 18 to 24, 25 to 34, 35 to 49, 50 to 64, and 65 years and above
- Males or females
- People in socioeconomic groups “ABC1” (people employed in higher and intermediate managerial, administrative or professional jobs or in supervisory, clerical and junior management roles) and “C2DE” (people employed in skilled manual work or semi-skilled and unskilled work, and pensioners, casual workers and unemployed people living on state benefits)

- People living in Northern Ireland in Belfast, North Northern Ireland, South Northern Ireland, West Northern Ireland, and in Ireland in Dublin, the rest of Leinster (outside of Dublin), Munster, and Connacht or Ulster

Separate weighting variables were applied to the Northern Ireland and Ireland cohorts when data were analysed separately. When using a pure, random sample, the margin of error on a sample of 1,000 for each omnibus survey is plus or minus 3.1 per cent (when analysed individually) and for the whole island of Ireland sample of 2,000 respondents the margin of error is plus or minus 2.2 per cent (at a 95 per cent level of confidence).

Measures and procedures

The data from the online pilot questionnaire and the elicitation study (the focus groups) were used to design a quantitative survey questionnaire to determine factors influencing food supplements use, used to assess a 2-component model of the Theory of Planned Behaviour. The format and design of the survey questionnaire was in keeping with the Theory of Planned Behaviour framework and the “TACT” principles – target, action, context and time – were employed to define the behaviour (25) (Figure 2).

Figure 1The “TACT” principles – target, action, context and time – used to develop the Theory of Planned Behaviour survey questionnaire in a quantitative study exploring food supplements use among adults on the island of Ireland.

Target	Action	Context	Time
Adult sample	Food supplements use	Everyday life	Within the next month

Direct measures of *intention, attitude, subjective norms* and *perceived behavioural control* (including *self-efficacy* and *controllability*) were included with 3 to 6 items per construct, all measured using 5-point Likert scales (Table 3). The items were developed to include the “TACT” principle elements of *target* and *action* (that is, adults taking food supplements) and *time* (within the next month).

Statements to assess participants’ *indirect beliefs* towards food supplements were created from the most common themes from the elicitation study (stage 1). *Behavioural beliefs, normative beliefs* and *control beliefs* (scored from 1 to 5) were multiplied by outcome evaluations, motivation to comply and power (scored from minus 2 to plus 2), respectively. Positive scores overall indicated that the participant was in favour of, experiences social pressure to, and feels in control of taking food supplements.

The Theory of Planned Behaviour component of the survey yielded a total of 9 outcome variables (overall scores for)

- Intention
- Attitude
- Subjective norms
- Self-efficacy
- Controllability
- Perceived behavioural control
- Behavioural beliefs
- Normative beliefs
- Control beliefs

The survey questionnaire also included assessed

- Sociodemographic factors (for example age, gender, socioeconomic status)
- Current food supplements use behaviour
- Patterns of use in current users (such as types, frequency, duration, context of use)
- Types of food supplements previously taken by past users
- Parents' and child-carers' food supplements use (where applicable)
- Participants' awareness and knowledge of food supplements
- Perceived health status ("Very healthy" to "Very unhealthy")
- Diagnosis of a physical or mental health condition ("Yes / No")
- Other life stage or lifestyle choices (for example being pregnant, breastfeeding, vegetarian or vegan)

From these questions, a further 3 scores were calculated for

- Perceived health status
- Knowledge of food supplements
- Awareness or risk or safety related to food supplements use

The final quantitative survey was piloted on 13 April 2021 and was completed by 35 respondents. The resulting data were reviewed and analysed to ensure the questionnaire was working fluently, that there were no filtering errors, and that no questions were yielding high proportions of "Don't know" responses. Fieldwork data collection for the main survey was then conducted from 14 to 30 April 2021. The full questionnaire is included in Appendix 2.

Table 3 Quantitative survey questionnaire items and Cronbach's alpha reliabilities for each Theory of Planned Behaviour construct assessment measure in a study exploring food supplements use in adults on the island of Ireland

Theory of Planned Behaviour construct	Number of items	Questionnaire items, assessed using 5-point Likert scales	Cronbach's alpha (α)
Intention	3	I want / I intend / I am going to use a supplement within the next month: Agree / Disagree Using a supplement within the next month would be Beneficial / Harmful Healthy / Unhealthy Good / Bad Wise / Foolish	0.982
Attitudes	4	I feel under social pressure / It is expected of me / People who are important to me think I should / People who are important to me want me to use a supplement within the next month: Agree / Disagree For me to use a supplement within the next month is Easy / Difficult	0.912
Subjective norms	4	People who are important to me want me to use a supplement within the next month: Agree / Disagree For me to use a supplement within the next month is Easy / Difficult	0.890
Self-efficacy	3	I am confident / I am sure that I could use a supplement within the next month if I wanted to: Agree / Disagree The decision to use a supplement within the next month is beyond my control / It is mostly up to me / Whether I use a supplement or not within the next month is entirely up to me:	0.862
Controllability	3	Agree / Disagree <i>(A combination of the “self-efficacy” and “controllability” items)</i>	0.617
Perceived behavioural control	6		0.786

Data quality

In the omnibus surveys in both Northern Ireland and Ireland, Cognisense implements additional quality checks to ensure the quality and integrity (the accuracy and reliability) of resulting data. A range of measures are included, such as: “security questions” to provide sense checking (simply, ensuring the questions and responses are relevant and make sense); removal of “back

button” facilities so that respondents cannot navigate filtering; “quality questions” set against national statistics to test data accuracy; and minimum time limits on each question.

Before being finalised, data are subject to a full interrogation to remove any duplicates and a manual, line-by-line sense check to remove “speeders”. Oversampling ensures total samples are achieved.

Data analyses

Data were analysed using IBM SPSS Statistics® software version 26 (International Business Machines [IBM] Statistical Package for Social Science [SPSS], IBM, Armonk, New York, USA) and all analysis was conducted on weighted data for the island of Ireland population. Descriptive statistics were used to present the data in tables or figures, where appropriate: number, or “n”; percentage, or “%”; mean, or average, values; and the standard deviation from the mean, or “SD”, which indicates the range of variation above and below the average values).

Differences between groups (for example food supplements users as against non-users) were compared using “t-tests”, “analysis of variance” or “chi-squared tests” as appropriate.

Internal reliability (the level of consistency in the results of the questioning process) was assessed using Cronbach’s alpha (α).

Pearson’s bivariate correlations, hierarchical logistic and linear regression analyses were used to determine predictors of food supplements use and intentions to use food supplements.

Probability values, or “P”, less than 0.05 were considered significant throughout. (“P” is a measure of the probability that a finding is true, even if it seems unlikely, rather than occurring by chance or accident.)

4 Results

Literature review

Introduction

Food supplements exist in many different forms but they all fall under a common definition set by the European Commission as

“FOODSTUFFS THE PURPOSE OF WHICH IS TO SUPPLEMENT THE NORMAL DIET AND WHICH ARE CONCENTRATED SOURCES OF NUTRIENTS [VITAMINS OR MINERALS] OR OTHER SUBSTANCES WITH A NUTRITIONAL OR PHYSIOLOGICAL EFFECT, ALONE OR IN COMBINATION, MARKETED IN DOSE FORM, NAMELY FORMS SUCH AS CAPSULES, PASTILLES, TABLETS, PILLS AND OTHER SIMILAR FORMS, SACHETS OF POWDER, AMPOULES OF LIQUIDS, DROP DISPENSING BOTTLES, AND OTHER SIMILAR FORMS OF LIQUIDS AND POWDERS DESIGNED TO BE TAKEN IN MEASURED SMALL UNIT QUANTITIES”

Food supplements might include a wide range of nutrients and other ingredients, “including, but not limited to, vitamins, minerals, amino acids, essential fatty acids, fibre and various plants and herbal extracts” (26).

The use of food supplements has become a widespread practice globally and has been best documented in the US, where over half of adults report food supplements use (8). In contrast, across Europe, reported levels of supplement use vary significantly. Similar to the US, up to half of UK adults are reported to take food supplements on a regular basis and a further third have taken them in the past (27). In Ireland, however, the National Adult Nutrition Survey found that only 22 per cent of men and 33 per cent of women (aged 18 to 64 years) reported the use of food supplements. In Spain, food supplements use was as low as 9.3 per cent. It is important to note that these variations may be due to differences in the way supplement use has been reported: the UK figures were derived from a specific survey on supplement use – whereas the figures for Ireland and Spain have been derived from nationally representative dietary surveys, which may provide a more accurate representation of actual supplement use within the general population.

The reported use of food supplements in the UK (10) (Table 4) and Ireland (Irish Universities Nutrition Alliance, 2011) (29) is 20 to 50 per cent (depending on gender and age group and often increasing with age). This is in contrast to current healthy eating guidelines, which promote a “food first” approach providing food-based recommendations to achieve an adequate diet without the need for additional supplementation within a healthy adult population. The exceptions are for specific supplementation:

- During illness.
- Within at-risk groups, such as a 400-microgram per day folic acid supplement for women of childbearing age and in pregnancy.
- Vitamin D supplementation across the population. The UK Government advises that adults (including pregnant and breastfeeding women) and children over 4 years old should consider taking a daily vitamin D supplement (5 to 10 µg) between the months of October and March as it is not possible for people to produce enough of their own vitamin D (from sunlight on exposed skin) during these months. At-risk groups, such as those with dark skin or limited sunlight exposure, are advised to consider supplementation year-round. In addition, it is recommended that breastfed babies up to 1 year of age are given a daily supplement containing 8.5 µg to 10 µg and children aged 1 to 4 years are given a daily supplement containing 10 µg vitamin D (3). Furthermore, based on the Food Safety Authority of Ireland's (FSAI) advice (30), the Department of Health in Ireland has recently updated its guidance, stating that all children (aged 1 to 5 years) should be given a vitamin D-only (5 µg) supplement and older adults (65 years and above) should also take a 15-µg vitamin D supplement during extended winter months (31).

All supplements recommended in the context of public health policy summarised in Table 5.

Table 4 Overview of unweighted data from United Kingdom National Diet and Nutrition Survey Rolling Programme Years 1 to 9 (2008/09 to 2016/17) reporting food supplements use in the past year by country

	Adults 19 years and above				Children aged 1.5 to 18 years			
	YEARS 1 to 4	YEARS 5 and 6	YEARS 7 to 8	YEAR 9	YEARS 1 to 4	YEARS 5 and 6	YEARS 7 and 8	YEAR 9
	Sample n = 3,441	Sample n = 625	Sample n = 1,417	Sample n = 647	Sample n = 3,364	Sample n = 572	Sample n = 1,306	Sample n = 606
	No. of users (% of country)							
<i>Any supplement</i>								
England	603 (35.0)	160 (35.4)	~	~	427 (25.0)	102 (24.2)	~	~
Wales	124 (32.6)	36 (32.7)	~	~	63 (19.4)	24 (24.0)	~	~
Scotland	257 (29.7)	14 (32.6)	~	~	165 (20.1)	6 (18.8)	~	~
Northern Ireland	136 (28.9)	3 (15.0)	~	~	93 (18.2)	3 (16.7)	~	~
United Kingdom total no. of users (% of UK sample)	1,120 (32.6)	213 (34.1)	~	~	748 (22.2)	135 (23.6)	~	~
<i>Vitamin D or folic acid containing supplement</i>								
England	~	96 (24.1)	206 (22.6)	118 (28.6)	~	86 (20.9)	142 (16.5)	79 (20.8)
Wales	~	20 (17.0)	64 (27.2)	19 (17.9)	~	16 (14.2)	32 (16.3)	8 (9.3)
Scotland	~	9 (21.4)	11 (13.6)	7 (17.5)	~	10 (21.7)	2 (3.3)	7 (24.1)
Northern Ireland	~	23 (22.1)	27 (14.2)	13 (14.8)	~	16 (13.8)	21 (11.2)	12 (10.7)
United Kingdom total no. of users (% of UK sample)	~	148 (22.3)	308 (21.7)	157 (24.3)	~	128 (18.7)	197 (15.1)	106 (17.5)
<i>Not vitamin D or folic acid containing supplement</i>								
England	~	87 (21.8)	194 (21.3)	92 (22.3)	~	45 (11.0)	91 (10.6)	35 (9.2)
Wales	~	20 (17.0)	46 (19.6)	17 (16.0)	~	14 (12.4)	17 (8.7)	6 (7.0)
Scotland	~	6 (14.3)	12 (14.8)	4 (10.0)	~	4 (8.7)	4 (6.7)	0 (0.0)
Northern Ireland	~	16 (15.4)	29 (15.3)	5 (5.7)	~	8 (6.9)	11 (5.9)	6 (5.4)
United Kingdom total no. of users (% of UK sample)	~	129 (19.5)	281 (19.8)	118 (18.2)	~	71 (10.4)	123 (9.4)	47 (7.8)

Table 5 Current nutrition supplementation guidelines and recommendations across the island of Ireland

Folic acid		
Ireland (32) ¹	It is recommended that all women who may possibly become pregnant within the next three months, whether intentionally or not, are advised to take oral Folic Acid (FA) 400 micrograms daily to prevent Neural Tube Defects (NTDs). If you do become pregnant, you should continue to take folic acid for the first 12 weeks of pregnancy. The supplement should contain 400 micrograms of folic acid. Some women may need to take more.	
Northern Ireland (33)	It is advised that all women who could become pregnant, prior to conception and until the twelfth week of pregnancy should take a folic acid supplement. The supplement should contain 400 micrograms of folic acid. Women with a history of a previous neural tube defect affected pregnancy are advised to take 5 milligrams per day of folic acid for the same timeframe.	
Vitamin D		
Ireland (31)	Infants (0 to 12 months) ² 5 micrograms per day throughout the year for infants if they are breastfed or taking less than 300 millilitres (10 fluid ounces) of infant formula a day (HSE) . A liquid supplement that contains Vitamin D only is recommended.	

¹ Department of Health (2019) Folic Acid Supplementation. Report by the Department of Health Folic Acid Policy Committee. <https://assets.gov.ie/228532/293d8869-a5ed-4a2a-9a59-3417f18958a9.pdf>

² HSE. 2018. Vitamin D for babies 0 to 12 months. [Vitamin D for babies 0 to 12 months - HSE.ie](#)

Children (1 to 4 years) ³	A 5 microgram vitamin D only supplement is recommended in the form of a liquid supplement or drops from Halloween (31st October) to St Patrick's Day (17th March).
Older adults (65 years and above) (34)	15 micrograms - choose a supplement that contains 15 microgram (15µg) of vitamin D. This can be: a multi-vitamin supplement that contains 15 microgram (15µg) of vitamin D; a calcium and vitamin D supplement that contains 15 microgram (15µg) of vitamin D; or a vitamin D only supplement that contains 15 microgram (15µg) of vitamin D.

Northern Ireland⁴

Infants (0 to 12 months)	8.5–10 micrograms per day throughout the year. Infants (including babies who are exclusively or part breastfed) from birth to one year of age unless they are drinking 500ml (1 pint) or more of infant formula are advised to take 8.5–10 micrograms per day throughout the year.
Children (1 to 4 years)	10 micrograms per day throughout the year
People who are not exposed to much sun or who cover up their skin for cultural reasons	10 micrograms per day throughout the year
People with dark skin	
Everyone aged 5 years and over (including pregnant and breastfeeding women)	10 micrograms per day - During the summer months most people will usually get enough vitamin D from sunlight, so you may choose not to take a supplement over the summer months (late March/April to the end of September).

³ Department of Health (2020) The Children's Food Pyramid. Department of Health, Dublin. [gov.ie - The Children's Food Pyramid \(www.gov.ie\)](http://gov.ie - The Children's Food Pyramid (www.gov.ie))

⁴ Public Health Agency (2020). Vitamin D and You. [VitaminD_leaflet_01_20.pdf \(hscni.net\)](http://VitaminD_leaflet_01_20.pdf (hscni.net))

With an increase in demand for food supplements there has also been an increase in the availability of food supplements online through websites as well as from a variety of outlets that sell food supplements, including health food shops, chemists, supermarkets, gyms and beauty salons (35, 36) (27). This increased availability, in combination with effective marketing and advertising in the increasingly digital world, and the common belief among consumers that food supplements are only of benefit to health, has led to concerns surrounding the uncontrolled use of food supplements (35). This is of particular concern for food supplements containing certain nutrients, including vitamin E or vitamin A, for which there is increasing evidence that high intakes may be more harmful than beneficial (37). Therefore, from a regulatory perspective it is important that the food supplements industry is honest and transparent, with consumer safety overriding commercial interests.

The regulation of food supplements is complex, involving a number of different bodies, across different countries and regions. The European Commission Food Supplements Directive 2002/46/EC provides a list of vitamins and minerals that may be added to food supplements for nutritional purposes and also provides a list of permitted sources from which those vitamins and minerals may be manufactured (38). However, it has been argued that consumers' safety could be at risk due to flaws in European Union and national legislations claiming that it is a "relatively loose regulatory framework" (39). However, the European Food Safety Authority (EFSA) has recently strengthened the framework outlining tolerable upper limits for some vitamins and minerals included within supplements (40).

A greater understanding of their use within the general population is required to help inform future nutrition and dietary policies and ensure effective communication to consumers. The aim of this review was to

- Critically analyse current evidence investigating consumer knowledge, attitudes and behaviours towards food supplements

Consumer motivations

With the use of food supplements widespread across the population it is important to understand the main drivers and reasons why consumers may or may not take food supplements. The findings from 18 studies in this area are summarised in Table 6.

A German study identified 3 main categories or subgroups for supplements users: "prevention", "prevention and additional benefits", and "treatment" (41). Just over half of respondents (52 per cent) were classified into the "prevention" subgroup, where consumers' main motivations for supplement use was the "*prevention of nutrient deficiencies*" or "*disease prevention*". The

“prevention and additional benefits” subgroup (27 per cent of respondents) included those who reported additional motivations including “*improvement of general wellbeing*”, “*enhancement of physical or mental performance*” and “*compensation for inadequate dietary intake*”. The remaining 21 per cent of respondents were classified into the “treatment” subgroup; their main motivations for food supplements use was for the “*treatment of nutrient deficiencies*” and to “*support disease treatment*” (41) (24).

The rationale for supplement use of “general health improvement” is one of the most common motivations reported across many studies (8, 35, 42). Rogza and colleagues (2013) reported that almost half of supplement users (42 per cent) believed food supplements were an essential component of health. However, as the majority of participants (73 per cent) included in this study were regular supplement users, this attitude may not be representative of the general population.

It is important to understand also why some individuals might not take food supplements. The main barriers to supplementation recently reported (in a sample of 358 healthy Greek adults) were the perceived lack of health benefits (24 per cent), preference of natural products (19 per cent) and lack of information at the point of purchase (15 per cent) (24), suggesting that the main barriers to supplements use are product-related or “intrinsic” factors. A recent study among 524 students in Iran, however, reported that those living in urban areas, with a higher household income, were more likely to be supplements users (43), indicating that “extrinsic” factors such as cost and product availability may be important predictors of food supplements use.

Whilst the focus of this review has been on the personal use of food supplements by adults, it is important to address food supplements use in children and to consider parental motivations towards supplementing their child’s diet, which have been found to mirror that of general consumers (44). Interestingly, however, parents, or those with children in their care, have reported that they were heavily influenced to supplement their child’s or children’s diet due to recommendations from a healthcare provider (45, 46). This indicates that healthcare providers are an important influence on parents and those with children in their care. It is therefore important that healthcare providers have accurate and up-to-date information about food supplements and their use.

Sociodemographic, lifestyle and health characteristics

Previous research has identified certain demographic groups who may be more likely to report food supplements use – for example females, those with a higher education and those who have a higher household income or socioeconomic status (47, 48). Ethnic variation has also been

reported among supplements users, with use observed to be greatest among the non-Hispanic White community (9, 49). Furthermore, it has emerged that those who follow healthier lifestyles, including those who are nonsmokers, report higher levels of physical activity and are within a healthy Body Mass Index (BMI) range are more likely to be food supplements users (50, 51) (Rozga and colleagues, 2013)(52). Athletes are more likely to use food supplements in comparison with the general population, with a higher prevalence of supplements use observed in elite (top) athletes in comparison with nonelite athletes (53). Certain dietary patterns have also been shown to be associated with food supplements use, for example among people who follow special diets and those following a “Mediterranean style” diet (24, 47). Such findings have led to claims that food supplements use is greatest among those who are least likely to need to supplement their diet as their nutritional intake from food is already sufficient, a paradox (a conflict or contradiction) that has previously been named “inverse supplement hypothesis” (54). This has been explored in a large German study of 1,589 individuals, which quantified the nutrient profiles of food supplements users as against non-users. The results showed that, compared with non-users, supplements users typically had higher intakes of several micronutrients from food sources alone, even before considering the impact of food supplements (41). Such evidence supports the inverse supplement hypothesis and supports the growing body of evidence suggesting that a health-conscious attitude is a prominent characteristic among food supplements users.

As it is evident that food supplements use is becoming more prevalent, it is increasingly important that consumers are adequately informed and are purchasing food supplements from appropriate channels (36) (Lentjes and colleagues, 2016) (48). A recent FSA report found that supermarkets (42 per cent), pharmacies (30 per cent) and health food shops (24 per cent) remained the most popular locations from which to buy food supplements, among UK adults. Additionally, Tsartsou and colleagues (2020) reported that within a Greek adult study population (358 individuals), healthcare professionals and the Internet were the primary sources of information on food supplements, although the main point of purchase was the pharmacy. These findings are encouraging as they highlight confidence among consumers in healthcare professional advice, and confirm that food supplements are commonly bought from reputable outlets.

Pre-conception and pregnancy

The diet and lifestyle choices a female makes during pre-conception and pregnancy have important implications for the mother and the unborn child (55, 56). Women of childbearing age are advised to take a 400-microgram folic acid supplement during pre-conception and up until

the first 12 weeks of pregnancy, based on conclusive evidence for the protective role of folate against neural tube defects (57). (The “neural tube” eventually develops into the baby’s spine and brain.) In the case of vitamin D and omega-3 fatty acids, varying degrees of causal linkage to pregnancy outcomes, foetal health or maternal health have been reported (58, 59). (“Causal linkage” is simply the strength of the link between a particular effect and a possible cause of that effect.)

Table 7 outlines 15 studies that have analysed supplementation practices specific to pre-conception and pregnancy. Data from the “EuroPrevall” birth cohort (a large-scale project observing the prevalence, cost and basis of food allergy in Europe) has shown that maternal dietary habits and the use of dietary supplements during pregnancy varies significantly across Europe (55). Focussing on folic acid supplementation, the highest levels were reported in Spain (97.8 per cent) and the UK (88.1 per cent), with the lowest uptake reported in Lithuania (55.6 per cent). This highlights the importance of effective public health strategies, as in countries such as the UK where there are clear folic acid supplement recommendations females were more likely to take folic acid during their pregnancy (55). This has been explored further in the Swedish “GraviD” study, investigating the association of vitamin D status during pregnancy with preeclampsia (a pregnancy-related conditions with symptoms that often include high blood pressure, protein in the urine and swelling in feet and ankles) and pregnancy-induced hypertension (high blood pressure), which reported high levels of compliance with folic acid supplementation recommendations (74 per cent) (56). Furthermore, both the GraviD study and the EuroPrevall study identified clear socioeconomic divisions in the use of dietary supplements in early pregnancy, whereby folic acid supplement users were more likely to be older, have a higher level of education, be in better employment and have higher household income (56).

Previous **safefood**-commissioned research has shown that compliance to guidelines for folic acid supplementation on the island of Ireland for women of childbearing age, and during pre-conception and pregnancy, are low (60). These findings may indicate that cost is a significant barrier, preventing women from less advantaged socioeconomic backgrounds from following public health advice and supplementing their diet. From a public health perspective this is significant, as the differences that have been observed in nutritional behaviour during pregnancy may make it more likely for babies born to disadvantaged parents to suffer further health inequalities (61).

Older adults

Increasing age is often accompanied by increased nutritional risk; therefore, dietary supplementation has become a common practice among many older adults (62-64). Three key papers investigating supplements use within older adults have been outlined in Table 7.

With national surveys showing that the proportion of older adults (60 years and above) within most populations is increasing (65) (United Nations, 2013), healthy ageing has become an important focus of global public health policy. The UK “Hertfordshire Cohort Study” of adults (participants were born between 1931 and 1939) observed that almost half of study participants (45 per cent of males and 58 per cent of females) reported food supplements use (66). Similarly, UK NDNS data show that 41 per cent of older adults took a food supplement, and quantify that such supplementation made significant contributions to intakes of vitamin D (41 per cent), vitamin C (21 per cent) and B-vitamins (11 per cent to 31 per cent) (Roberts and colleagues, 2018) (61).

It is also important to note that in the present studies investigating supplement use in older adults (Table 7) a common theme emerged whereby health-related reasons were the primary motivations for taking food supplements, including the prevention of specific diseases common in old age such as osteoporosis (a condition that weakens bones) (63, 64). Despite the high levels of reported supplementation within some older cohorts, recent evidence from "The Irish Longitudinal Study on Ageing" has shown that there is a substantial number of older adults living in Ireland that are at risk of deficiency in key micronutrients including vitamin B12, folate and vitamin D (6, 44). Research in this area is particularly timely, as the COVID-19 global pandemic has highlighted the importance of ensuring sufficient micronutrient status within at-risk groups, including older adults (44). Indeed, a recent “infodemiology” study (a type of research focussed on scanning the Internet for user-contributed health-related content, with the aim of improving public health) using Google® Trends® data has demonstrated an increase in searches for vitamins since the beginning of the COVID-19 pandemic (67). Therefore, the role of food supplements within this population group cannot be ignored. From a public health perspective it is essential that older people are educated about food supplements and their use.

Safety concerns

With the increasingly widespread use of food supplements, which is not advocated in dietary guidelines, it is important that supplements users understand how these products may interact with other supplements or with foods or medications. It is clear from the literature, however, that risk perception is generally quite low among supplements users. For example, in Switzerland, Troxler and colleagues (2013) reported that an overwhelming majority of adults (75

per cent) believed that dietary supplementation presents “no risk” or “hardly any risk”. Similarly, in a study of 686 Italian teenagers, 76 per cent of supplements users were unaware of any potential adverse effects associated with food supplements use (68). Furthermore, as evident in Table 6, reported concerns surrounding the safety of food supplements is not well documented in dietary guidance nor understood by consumers. Future research is warranted to investigate consumer awareness of safe and responsible use of food supplements, such as their awareness of dosage limits and possible interactions between medications and nutrient supplements.

Similarly, it is difficult to obtain relevant literature that has investigated the prevalence of adverse events following food supplements use, which may suggest supplement users are not actively reporting adverse events they may have experienced. In France, to ensure there is an effective reporting system in place, regulatory bodies have developed and implemented a nutrивigilance scheme that rapidly identifies and monitors adverse effects associated with the consumption of food supplements, so improving consumer safety (13). Other regulatory bodies across Europe should work towards adopting and implementing a similar surveillance system (Pourshahidi and colleagues, in press).

Conclusions

Overall, this review has highlighted that food supplements are used by an increasing proportion of the population, therefore their contribution to diet, health and disease has the potential to be significant. It is evident that there are many reasons consumers may choose to supplement their diet, including for general health improvement, to ensure adequate nutrition and to prevent disease. Reasons for *not* taking or for stopping taking supplements are less commonly reported within the literature.

There are significant challenges in defining a “typical” supplements user, owing to the great variety of study populations and designs. The body of evidence shows, however, that food supplements use is generally greater among females, older adults, those with a higher level of education and those who make healthier lifestyle choices. Furthermore, there appear to be distinct socioeconomic differences between supplements users and non-users, indicating that cost may be a significant barrier preventing those who may truly benefit from food supplements use.

Food supplements have an important role to play in correcting deficiencies and optimising nutritional status in specific population groups, and so have an important place in public health guidance. Among the general population, however, safety issues remain a concern, particularly around the increasing availability of supplements from a wide range of suppliers and, therefore,

the increased likelihood of “multidosing” from more than 1 source or product. It is apparent that, among supplements users, food supplements are generally perceived as “low-risk” products, indicating that there is an increased need for greater public health awareness of both the undesirable as well as desirable effects of supplementation. This review highlights that there is a need to improve public health guidelines and nutrition policy to ensure the safe and appropriate use of food supplements.

Table 6 Observational studies investigating the prevalence of food supplements use, and consumer attitudes and motivations towards these products, in adults, students, adolescents or teenagers, and patients

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns
Adults								
Tsartsou and colleagues (2020)	Greece	358	Online questionnaire	42.0	Protein (61.0) Vitamins and minerals (10.6)	Prevention of a health problem (28.0) Curiosity (21.0) Existing health problem (13.0)	Higher education, consumer knowledge and income were significantly associated with food supplements use. Food supplements users reported greater awareness of healthy eating and greater adherence to a "Mediterranean style" diet.	Food supplements users reported concern as to product labelling and health claims. They prefer to purchase dietary supplements or "functional food" (food products with added ingredients to improve health or physical or mental functions) from pharmacies.
Students, adolescents or teenagers								
Frey and colleagues (2017)	Germany	1,589	24-hour dietary recalls and telephone interview	40.0	Not reported	General wellbeing (85.0) Prevention of nutrient deficiencies (76.0) Disease prevention (75.0) Correct nutritional deficiencies (67.0) Improve physical or mental performance (84.0) Disease treatment (60.0) Maintain an adequate dietary intake (56.0)	No significant differences reported; users do not form a homogeneous (consistent or uniform) group.	Not reported

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns
Tarn and colleagues (2015)	US	603	Self-administered questionnaire	79.0	Vitamins and minerals (49.0)	Not reported	Women, older patients and those with a higher level of education and more comorbidities (more than 1 illness occurring at the same time as another) were more likely to take supplements. Non-Hispanic Whites and Asians were more likely to take supplements than patients of other races or ethnicities.	Over half of respondents perceived no risk in taking supplements.
Owens and colleagues (2014) (69)	US	526	Self-administered questionnaire	71.5	Vitamin or mineral (83.1) Fish oil (53.0) Melatonin (18.1) Garlic (13.3) Other (12.7)	Not reported	Not reported	65 per cent of food supplements users expressed concerns regarding label information.
Troxler and colleagues (2013)	Switzerland	252	Self-administered questionnaire	58.0	Multivitamins, botanicals, protein products and products containing essential fatty acids (No percentages provided)	To improve wellbeing and common issues such as fatigue. 10.0 per cent stated that they took dietary supplements to prevent an illness.	Not reported	75 per cent of food supplements users reported no risk or hardly any risk in taking supplements. 39 per cent stated that they looked for potential risks of the products they used.
Kozicky and colleagues (2013) (70)	Canada	192	Self-administered questionnaire	33.0	Multivitamins (39.0) Vitamin C (24.0) Iron (8.0)	Not reported	No significant differences reported for age, gender, BMI, education, marital status, income support, employment and chronic disease diagnosis between food supplements users and non-users.	Not reported
Pouchieu and	France	79,786	24-hour dietary recall	41.0	Magnesium (42.1)	Overcome tiredness (41.5)	Food supplement users were more likely to be women, older,	Not reported

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns	
colleagues (2013)					Vitamin B6 (29.8) Vitamin C (27.2) Zinc (25.1) Iron (24.3) Vitamin E (23.5) Thiamin (22.5) Vitamin D (22.3) Riboflavin (22.1) Folate (21.0) Pantothenic acid (19.8) Calcium (19.6) Niacin (17.2) Selenium (17.0) Vitamin B12 (16.5) Vitamin B8 (14.6)	Stay healthy (33.8) Health problems (32.3) Beauty (15.3) Stress (14.7) Stay young (8.9) Pregnancy (7.0) Lose weight (5.0) Compensate for deficiencies (4.7) Intellectual performance (4.4) Specific sporting needs (4.3)	more educated, better employed and more physically active, non-smokers, have a lower BMI and to follow a restrictive diet. Food supplements users followed a healthier diet than non-users.		
Bailey and colleagues (2013)	US	11,956	Analysis of National Health and Nutrition Examination Study (NHANES) data 2007 to 2010 (Questionnaire was used)	49.0	Multivitamin-mineral (31.9) Calcium (11.6) Fish oil (9.8) Vitamin C (7.1) Multivitamin (5.7) Vitamin D (4.9) Vitamin E (3.7) Joint supplements (4.0) Vitamin B12 (3.3) Iron (1.8) Folic acid (1.5) Protein or sports	Improve overall health (45.0) Maintain health (32.8) Bone health (25.2) Supplement the diet (22.0) Prevent health problems (20.4) Heart health (15.1) Boost immunity, (14.5) Healthy joints, prevent arthritis (12.4) Anaemia (4.6)	Supplements use was higher among females and older adults (60 years and above). Healthy weight and overweight adults were more likely to report supplements use over those who were underweight or living with obesity. Food supplements use was higher among those who reported higher levels of physical activity and those who reported excellent or very good health.	Not reported	

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns
Braun and colleagues (2010) (71)	Australia	1,121	Questionnaire	72.0	Dietary supplement use supplements (1.6) Multivitamin (49.0) Fish oil (47.0) Vitamin C (31.0) Glucosamine (29.0) Vitamin B complex (25.0) Probiotic (17.0)	Not reported	Greater reported use among females. Differences in type of supplements chosen by age.	92 per cent of food supplements users believe pharmacists should provide safety information about supplements.
Rovira and colleagues (2012)	Spain	6,348	Self-administered questionnaire	9.3	Multivitamin, multimineral (56.8) Fatty acids (16.8) Antioxidants (10.1)	Not reported	Greatest reported use among female participants. Food supplements users were younger, had lower BMI and higher level of education than non-users. Dietary analysis showed that those who followed a healthier "Mediterranean style" diet were more likely to consume dietary supplements.	Not reported
Lentjes and colleagues (2016)	UK	25,639	European Perspective on Cancer – Norfolk (EPIC-Norfolk) questionnaire	69.0	Males: Cod liver oil (43.0) Garlic (12.0) Multivitamin (11.0) Females: Cod liver oil (32.0) Multivitamin (11.0) Primrose oil (10.0)	Not reported	Significant sociodemographic associations were found between supplements use and age, smoking, social status and education. Food supplements users also followed healthier diets.	Not reported

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns
Dickinson and colleagues (2014) (72)	US	8,361	Self-administered questionnaire	69.0	Multivitamin (71.0) Omega-3 or fish oil (33.0) Calcium (32.0) Vitamin D (32.0) Vitamin C (32.0) B vitamins (25.0) Vitamin E (19.0) Magnesium (12.0)	Overall health and wellness (58.0) Fill nutrient gaps in diet (42.0) Immune health (32.0) Healthy ageing (32.0) Energy (31.0) Bone health (30.0) Heart health (29.0)	Food supplements users followed healthier lifestyle habits, including adherence to a balanced diet, regularly getting a good night's sleep, exercising regularly and maintaining a healthy weight.	84 per cent of food supplements users stated their doctor knew they were taking supplements.
Students								
Salmani and colleagues (2020)	Iran	541	Food frequency questionnaire	23.5	Not reported	Attitudes and subjective norms were the key determinants of consumption of supplements including improvements in health, wellbeing and mood.	No statistical difference reported for gender. Higher level of parent education and urbanisation (living in a large town or a city) significantly increased the consumption of supplements. Attitudes and subjective norms were the key determinants of food supplement use.	Not reported
Sirico and colleagues (2018)	Italy	770	Self-administered questionnaire	37.4	Multivitamins were most popular, followed by stimulants, branched-chain amino acids (BCAA), protein and creatinine. Weight-loss products were least popular.	Sport performance (41.7) Wellbeing (28.6) Cognitive performance (8.7) Gain weight (3.8) Lose weight (3.8) Supplement dietary deficiencies (2.9)	No statistical difference reported for gender. Users of food supplements were slightly older than non-users and were mainly graduate (educated to degree level) health professionals.	Not reported

Author and year of publication	Country	Number in sample	Data collection method	Reported supplements use percentage	Type of food supplements reported (and percentage)	Attitudes and motivations for use (and percentage)	Sociodemographics of food supplements users	Reported concerns
Rozga and colleagues (2013)	US	629	Self-administered questionnaire	72.7	Not reported	Essential component of health (41.7)	Food supplements use was significantly higher among females and older participants as well as those who engaged in regular physical activity, avoid smoking and were within a healthy BMI range.	44.4 per cent of food supplement users felt confident in choosing their own supplement.
(73) Ahmed Al-Naggar and Chen (2011)	Malaysia	105	Questionnaire	43.8	Multivitamin only (30.5) Multivitamin and multimineral (20.0) Multimineral only (4.8)	Maintain good health (80.0) Ensure adequate nutrition (10.5) Weight loss (4.8) Enhance physical appearance (3.8)	There was a significant association between monthly household income and food supplements use.	Not reported
Adolescents / Teenagers								
Del Balzo and colleagues (2014)	Italy	686	Self-administered questionnaire	34.0	Not reported	Tone the body (36.0) Muscle mass (12.7) Health (28.9) Sport performance (21.9) Brain performance (7.0) Losing weight (5.7) Gain weight (4.8) Aesthetics (6.1)	Statistically significant differences emerged between the genders for the frequency of consumption, source of information regarding dietary supplements and place of purchase.	Only 24 per cent of respondents were aware of any negative consequence regarding dietary supplements use.
Patients								
Larussa and colleagues (2019)	Italy	137	Self-administered questionnaire	45.0	Herbal supplements (37.0) Nutraceutical compounds (26.0) Vitamins (15.0)	Food supplement users reported that it was a "more natural" way to treat symptoms.	Food supplements use was significantly greater among older participants, females and those with a higher level of education and income, better knowledge and who avoided smoking.	Not reported

Table 7 Observational studies investigating the prevalence of food supplements use and exploring attitudes and motivations for use pre-conception and during pregnancy and in older adults

Author and year of publication	Country	Number in sample	Study population	Data collection method	Reported supplements use (and percentage)	Type of food supplements reported (and percentage)	Attitudes and motivations for use	Sociodemographics of food supplements users	Reported concerns
Pre-conception and during pregnancy									
Jun and colleagues (2020)	US	9,707	Females (aged 20 to 44 years)	Analysis of NHANES data (1999 to 2014) (Questionnaire was used)	Pregnant: 70.0 Lactating: 70.3 Nonpregnant or nonlactating: 44.8	Thiamin Riboflavin Niacin Folic acid Vitamin B6 Vitamin B-12 Vitamin C Vitamin D Calcium Iron Selenium Zinc	47.4 per cent of food supplements users were influenced by a healthcare provider's recommendation. 16.1 per cent of pregnant women reported the use was based on their own decision.	Supplements use was higher among older females and those with a higher household income.	Not reported
During pregnancy									
Shawe and colleagues (2019) (74)	England	573	Males (aged 18 to 52 years)	Self-administered questionnaire	28.4	Multivitamins (68.1) Cod liver oil or fish oil (16.5) Preconception vitamins (23.3) Body-building supplements (19.6)	Not reported	Education was the main predictor leading to positive changes in pre-conception care.	Not reported
Knapik and colleagues (2018) (75)	Poland	505	Pregnant women	Cross-sectional questionnaire	81.2	Folic acid (81.2) Vitamin D (62.0) Polyunsaturated fatty acids (38.4)	Not reported	Respondents who reported food supplements use were more likely to be inhabitants of larger cities, with a higher level of education and household income.	Not reported

Bärebring and colleagues (2018)	Sweden	2,109	Pregnant and non- pregnant females	Self- administered questionnaire	78.0	Folic acid (74.0) Vitamin D (43.0) N-3 polyunsaturated fatty acids (5.0)	Not reported	Supplements use was associated with gestational age (stage of pregnancy), nulliparity (never having been pregnant before), country of birth, higher level of education, and higher employment status and income.	Not reported
Maraschini and colleagues (2017) (76)	Italy	562	Mothers	Interviews	19.40	Folic acid	Not reported	Older women and those with a higher level of education were more likely to use periconceptional (pre-conception and in early pregnancy) folic acid.	Not reported
Hirahara and colleagues (2017) (77)	Japan	103	Mothers	Dietary survey	During pregnancy: 48.9	Folic acid	84.4 per cent reported an awareness of the benefit of folic acid during pregnancy.	Did not investigate	Not reported
Hwang and colleagues (2016) (78)	Iraq	335	Pregnant women	Cross- sectional survey and face-to-face interviews	Pre- conception: 24.9 56.7	Vitamins (36.3) Herbs or “natural” products (53.7)	Not dangerous for pregnancy (42.9) Effectiveness (28.6) Cultural reasons for using herbs (17.5) Safety of foetus (10.6)	Rural residence, higher household income and perceived “healthy” status were associated with dietary supplements use.	Not reported
Charaf and colleagues (2015) (79)	Australia	412	Pre- conceptual females	Questionnaire	8.3	Multivitamin (41.7) Folic acid (56.3).	Not reported	No significant associations were identified in comparing user and non-user	Not reported

Holden and colleagues (2015) (80)	US	10,002	Women of childbearing age	Analysis of US National Health Interview Survey 2012	38.0	"Others" included herbal medicines	groups across education, employment status, salary or marital status.	
Dante and colleagues (2015) (81)	Italy	2,301	Mothers	Interviews	71.2	Did not investigate type of supplements consumed General wellness or disease prevention (35.0) Improving health or feeling better (19.0) Reducing stress or relaxing (16.0)	Those within a healthy weight range, engaged in physical activity and had a good perceived health status were more likely to take supplements.	Not reported
Moon and colleagues (2015) (82)	England	1,722	Mothers	Questionnaire	40.9	Multivitamins containing folic acid (31.8) Folic acid only (18.0) Vitamin D The main reported reasons were for health improvement and to improve energy levels Not reported	Those who worked were more likely to take folic acid.	Not reported
Agricola and colleagues (2014)	Italy	282	Pre-conceptual females	Online questionnaire	47.5	Folic acid Not reported	Food supplements use was greater among older females with a higher level of education and were nonsmokers. Women who were more knowledgeable, with a higher level of education level, were more likely to take folic acid supplements.	Not reported
Martin and colleagues (2014) (84)	Australia	200	Pregnant women	Cross-sectional survey questionnaire investigating iodine intake	79.0	Multivitamins, herbs and food supplements (No percentages provided) Not reported	Greater reported food supplement use among those with a greater knowledge.	Not reported

Lucas and colleagues (2014) (85)	Australia	142	Mothers	Cross-sectional survey	82.0	Folic acid-containing (77.0) Iodine-containing (70.0)	Not reported	Age was significantly associated with increased dietary supplements intake. There was no significant association between supplements intake and level of education or household income.	Not reported
Barbour and colleagues (2012) (86)	Scotland	211	Pregnant women	Self-administered questionnaire followed by focus groups	General food supplements use: 31.0 Use only in pregnancy: 56.0	Folic acid	Following public health advice or health advice from healthcare provider	Those taking food supplements were more likely to be older, have a higher level of education, live in a more affluent area and be married or living as if married.	Respondents expressed a lack of awareness of the functions of vitamins and folic acid supplements

Older adults

Shade and colleagues (2019)	US	138	Older adults (65 years and above)	Self-administered questionnaire	83.0	Vitamin D (46.0) Multivitamin (40.0) Calcium (37.0) Omega-3 fish oils (19.0) Vitamin C (14.0) Potassium (12.0) Glucosamine and chondroitin (11.0) Probiotic or gastrointestinal supplement (10.0) Eye health supplement (10.0) Folic acid (9.0)	Maintain health Manage joint or arthritis pain Prevent urinary tract infections Maintain gastrointestinal flora (gut bacteria)	Greater reported food supplements use among females, older participants and those with a healthy weight.	Not reported
Gahche and colleagues (2017)	US	3,469	Older adults (60 years and above)	Analysis of NHANES data (2011 to 2014) (Questionnaire was used)	70.0	Multivitamins (39.0) Vitamin D (26.0) Omega-3 fatty acid supplement (22.0) B-complex and B vitamins (16.0) Calcium and vitamin D (13.0) Vitamin C (11.0) Calcium only (9.0) Botanical or herbal	Improve overall health (41.0) Bone health (37.0) Maintain health (36.0) Supplement the diet (22.0) Heart health and cholesterol management (22.0)	Food supplements use was significantly higher among women, those with a higher level of education, higher income, private insurance, were nonsmokers, reported at least some physical activity, and who reported excellent or very good health status.	Not reported

Denison and colleagues (2012)	UK	3,217	Older adults (59 years and above)	Interview	Males: 45.4 Females: 57.5	supplements (9.0) Oils: Males (71.5) Females (69.9) Multivitamins: Males (5.1) Females (4.6) Minerals: Males (2.9)M Females (2.8) Vitamins and minerals: Males (16.8) Females (22.4)	Not reported	Food supplement use was associated with healthier diet and higher household income. Similar reported use among males and females.	Not reported
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Audit of a sample of the French Agency for Food, Environmental and Occupational Health and Safety's nutrivigilance newsletters

During the timeframe of the audit of the nutrivigilance newsletters from the French Agency for Food, Environmental and Occupational Health and Safety, a total of 170 adverse events were recorded (around 13 per month). The likelihood of the product directly causing the adverse event was classified as “possible” in 28 per cent of cases, “likely” in 51 per cent of cases and “very likely” in 16 per cent of cases; only 5 per cent of cases were deemed “less likely” or were not classified. Twenty products were linked to more than 1 reported adverse event (making a total of 78 cases, ranging between 2 and 28 cases per product). Cases were reported across a wide age-range of adults (from 18 to 90 years old), with around 10 per cent reported in children and often in children below 5 years old. Varying degrees of severity of adverse events were noted, spanning many different bodily systems and conditions.

Gastrointestinal (digestive tract, stomach and bowel), allergic, hepatic (affecting the liver) and cardiovascular-related (heart and lung) symptoms were commonly reported (Table 8).

The 69 scientific publications noted in the newsletters (around 5 per month) were international in nature, recently published (that is, between 2018 and 2020), from 35 countries. The aims of these articles were also varied. The top 3 research designs included observational studies (for example, from questionnaires or surveys), literature reviews and case reports (for example from medical notes). The complete audit data are included in Appendix 3 and Appendix 4.

This audit provides an evidence-based insight into clinical cases of adverse events associated with the consumption of food supplements and other food products. These findings may inform the translation into practice of the French nutrivigilance scheme as a model for the identification, reporting and monitoring of suspected adverse events related to the use of such products in other countries. Subsequently, this may improve knowledge of food supplements use and consumer safety, thus informing public health recommendations in this area (which are currently limited).

Table 8 Summary of adverse events by active ingredient from an audit of a sample of the French Agency for Food, Occupational and Health and Safety's nutrivigilance newsletters (number 59 August 2019 to number 71 August 2020), in decreasing order by number of reported cases per product

Product name (and producer), where available	Active ingredients	Dosage information	Age (or range) of cases (years)	Indication for use(s)	Number of cases of adverse events	Causality and number of cases	Number of reported cases per product	Newsletter number reporting adverse event(s)
Novanuit® (Sanofi-Aventis®)	<i>Passiflora incarnata</i> <i>Melissa officinalis</i> <i>Eschscholzia californica</i> Melatonin Vitamin B6	1 capsule per day	27 to 84	Sleep quality	Nausea (feeling sick): 2 Nightmares and anxiety: 1 Palpitations (fast or irregular heartbeat) and nightmares: 1 Headache: 4 Migraine (extreme headache): 1 Dizziness: 6) Drowsiness: 1 Sleepiness / Fatigue / Insomnia (sleeplessness): 4 Increased glycaemia (raised blood sugar): 1 Abdominal (stomach) pain: 1 Tachycardia (abnormally fast heartbeat): 1 Anxiety, delirium (mental confusion), nightmares: 1 Vomiting (being sick), discomfort: 1 Bloating, diarrhoea (loose bowel movements): 1 Oliguria (decrease in urine production: 1	Likely: 10 Possible: 16 Very likely: 2	28	59 62 63 64 67 69

					Heartburn, headache: 1 Headache and vomiting: 1 Headache and hypertension (high blood pressure): 1			
Piasflex® (Expanscience®)	Vitamin D Vitamin C Copper Manganese Collagen	1 capsule per day	47 to 86	Joint health	Nausea: 3 Vomiting: 1 Insomnia: 1 Oedema (swelling caused by excess fluid in body tissues): 1 Dizziness, nausea, cold sweats: 1	Possible: 2 Likely: 3 Very likely: 1	6	63 70 71
Anacaps® Progressiv® (Ducray® Pierre Fabre®)	Zinc Selenium Molybdenum Iron Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin C Vitamin E	1 capsule per day	40 to 78	Hair health	Nausea: 1 Abdominal pain and diarrhoea: 1 Diarrhoea and gastric reflux (heartburn): 1 Anxiety, tiredness, dizziness: 1 Itchy rash: 1	Very likely: 1 Likely: 3 Possible: 1	5	66
Anacaps® Reactiv® (Ducray® Pierre Fabre®)	<i>Oenothera biennis</i> oil Fish gelatin L-cystine L-methionine Vitamin B3	1 capsule per day	39 to 68	Hair and nail health	Constipation (slow bowel movements) and abdominal pain: 1 Abdominal pain and diarrhoea: 1	Possible: 2 Likely: 3	5	64 65

	Vitamin E Vitamin B6 Vitamin B8				Flatulence (wind) and abdominal pain: 2 Dyspepsia (indigestion), gastroesophageal reflux (heartburn): 1			
Chlorure de Magnésium (Gifrer®)	Magnesium chloride	120-gram sachet per day	Below 1 to 58	Strengthen and support your natural defences	Diarrhoea: 2 Diarrhoea and sleepiness: 1	Likely: 3	3	68
Berocca® Boost (Bayer® Consumer Health)	Coconut Oat fibre Spinach Pea proteins Aronia Acai Goji berry <i>Spirulina</i> Pomegranate Camu camu Blueberry Vitamin C Vitamin B12	1 capsule per day	19 to 28	Improve energy levels	Tachycardia, skin rash: 1 Tachycardia: 1 Nausea, trembling: 1	Possible: 2 Likely: 1	3	60 63
Alvityl® Défenses Sirop (Urgo®)	<i>Echinacea angustifolia</i> <i>Echinacea purpurea</i> Propolis Vitamin C	1 to 3 teaspoons (5 to 15 millilitres) per day (dependent on age)	5	Immune function	Rash, oedema: 1 Yellowing of teeth: 1	Likely: 1 Possible: 1	2	59
Dietary supplement with <i>Chlorella</i>	<i>Chlorella</i>	Not available	31 to 34	Not available	Constipation, abdominal cramps: 1 Gastrointestinal bleeding (light blood in stool): 1	Likely: 2	2	60

Equilibre Digest® (Microequilibre®)	Glutamine <i>Bifidobacterium bifidum</i> <i>Bifidobacterium breve</i> <i>Lactobacillus acidophilus</i> <i>Lactobacillus casei</i> <i>Lactobacillus helveticus</i> <i>Lactobacillus paracasei</i> <i>Lactobacillus plantarum</i> <i>Lactobacillus rhamnosus</i> <i>Curcuma longa</i> Vitamin B9 Vitamin D3	1 sachet per day	55 to 57	Gut health	Headache: 2	Likely: 1 Possible: 1	2	60
Dietary supplement containing <i>Tribulus terrestris</i>	<i>Tribulus terrestris</i>	Not available	44 to 47	Not available	Flatulence, cramps, diarrhoea: 2	Likely: 2	2	61
Dietary supplement with magnesium	Magnesium	Not available	44 to 47	Sleep	Flatulence, cramps, diarrhoea: 2	Likely: 2	2	62
Dietary supplement with guarana	Guarana	Not available	18 to 23	Athletic performance	Restlessness, increased heart rate, excessive sweating, headache, abdominal distension (bloating), increased urination: 1	Very likely: 2	2	62

					Nausea, irregular and more intense heartbeat, tingling sensation in the chest: 1			
DeCram® (Iprad®)	Magnesium Potassium Copper <i>Arnica montana</i>	1 capsule per day	81	Muscle support	Tongue, swallowing: 1 Worsening of a chronic obstructive pulmonary bronchitis: 1	Possible: 1 Likely: 1	2	65
Bion® 3 Défense Junior (Merck®)	<i>Lactobacillus gasseri</i> <i>Bifidobacterium bifidum</i> <i>Bifidobacterium longum</i> Vitamin A Vitamin B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin B12 Vitamin C Vitamin D Vitamin E Iron Zinc	1 capsule per day	Below 5	Immune function (children)	Diarrhoea and abdominal pain: 1 Abdominal pain: 1	Likely: 1 Not reported: 1	2	65
Chewable Hair Vitamins (Hairburst®)	Vitamin C Vitamin E Vitamin B5 Vitamin B6 Vitamin B12 Vitamin A	2 capsules per day	29 to 36	Hair health	Severe hepatitis (inflammation of the liver): 2	Very likely: 2	2	68

	Vitamin B8 Vitamin D Zinc Selenium							
Taïdo Ménoa® (Elerte®)	<i>Cimicifuga racemosa</i> Magnesium Vitamin B6	1 capsule per day	49 to 50	Menopause support	Hepatitis: 1 Increased transaminases (enzymes that may indicate inflammation of the liver): 1	Possible: 2	2	69
Ausilium 2oplus® (Deakos®)	<i>Morinda citrifolia</i>	1 sachet 2 or 3 times per day for 4 to 6 weeks	0 to 2	Not available	Vomiting: 2	Likely: 2	2	70
Naturactive Détox Sticks Fluide® (Pierre Fabre®)	Birch Dandelion Cherry stem	Not available	27 to 66	Fat metabolism and weight control	Diarrhoea: 1 Haematuria (blood in urine): 1	Likely: 2	2	59 65
Formag® (Pileje®)	Magnesium Vitamin B6 Taurine	1 to 2 capsules per day	38 to 49	Reduce fatigue and normal functioning of the nervous system	Rash: 1 Local pruritus: 1	Likely: 1 Possible: 1	2	65 71
Lactibiane® Enfant Gouttes (Pileje®)	<i>Bifidobacterium longum</i> <i>Lactobacillus helveticus</i> <i>Lactococcus lactis</i> <i>Streptococcus thermophilus</i> <i>Lactobacillus rhamnosus</i> Vitamin D3 Rapeseed oil	1 millilitre per day	21 months	Bone growth and development	Facial and ocular (eye) rash and pruritus (itchy skin: 1 Sleepiness: 1	Very likely: 1 Likely: 1	2	68 71

Oenobiol® Solaire Intensif Nutriprotection® (Oenobiol®)	<i>Camelina sativa</i> L. oil <i>Lycopersicon esculentum</i> Mill. <i>Tagetes erecta</i> L. M	1 capsule per day	11	Antioxidant properties	Acute hepatitis	Possible: 1	1	59
Oftamac+® (Europhta®)	Fish oil Vitamin C Vitamin B3 Vitamin E Vitamin B6 Vitamin B1 Vitamin B2 Vitamin B12 Vitamin B9 Vitamin D3 Lutein Zeaxanthin Zinc Manganese Copper Selenium	2 capsules per day	75	Antioxidant properties	Nausea, vomiting, diarrhoea	Likely: 1	1	59
Aloé Vera (Dieti Natura®)	<i>Aloe ferox</i> Miller	1 to 2 tablespoons per day	47	Digestive function and skin properties	Rash	Likely: 1	1	59
CarbBlock® (Oxygen®)	White kidney bean Fenugreek	2 capsules per day	26	Weight management	Hypoglycaemia (low blood sugar)	Likely: 1	1	59
Clinutren® Energy (Nestlé®)	Milk proteins Rape oil Minerals Vitamins	1 to 2 bottles per day	61	Nutritional supplement for children, providing additional	Rash	Likely: 1	1	59

				energy and protein				
Imgalt® (Jaldes®)	<i>Bifidobacterium lactis</i> <i>Bifidobacterium longum</i> <i>Lactobacillus acidophilus</i> <i>Lactobacillus paracasei</i> <i>Lactobacillus rhamnosus</i>	1 to 2 capsules per day	66	Gut health, natural defences	Infective endocarditis (infection of the heart)	Very likely: 1	1	59
Ergyphilus Plus® (Nutergia®)	<i>Lactobacillus rhamnosus</i> <i>Lactobacillus paracasei</i> <i>Lactobacillus acidophilus</i> <i>Bifidobacterium bifidum</i>	2 to 4 capsules per day	66	Gut health, natural defences	Infective endocarditis	Very likely: 1	1	59
Rexyl® Poudre (Epinum®)	Glutamine L-arginine Creatine Ginger	2 to 3 capsules per day	24	Promotes weight gain	Dyspnea (shortness of breath), tachycardia, abdominal pain	Likely: 1	1	59
Passiflore Bio® (Pharm&Nature®)	<i>Passiflora</i>	1 to 2 capsules per day	33	Sleep management	Hypereosinophilia (high count of eosinophils, which are white blood cells)	Very likely: 1	1	59
Nutrison Protein Plus® (Nutricia®)	Vitamins Minerals Proteins (milk, soy) Fish oil	Not available	90	Nutritionally complete enteral (stomach or intestinal) tube feed	Hypophosphoremia (low levels of phosphorous)	Very likely: 1	1	59

Energy drink	-	Not available	21	Not available	Chest pain, palpitations headache (consumer exceeding the recommended dosage)	Likely: 1	1	60
Dietary supplement containing Cat's claw	Cat's claw	Not available	40	Not available	Stomach discomfort (wrong dosage during consumption)	Likely: 1	1	60
Dietary supplement with vitamins and minerals (jelly)	Vitamins and minerals	Not available	30	Not available	Tongue swelling, rash	Likely: 1	1	60
Dietary supplement for constipation	Aloe vera gel	Not available	64	Not available	Rise in liver enzymes	Very likely: 1	1	60
Dietary supplement for growth hormone release, vitality	Vitamin C Vitamin B2 Vitamin B6 L-leucine L-valine L-isoleucine L-lysine L-phenylalanine L-threonine L-methionine L-arginine L-glutamine L-glycine L-carnitine L-konozin Chromium Selenium	Not available	83	Not available	Hypertirosis	Likely: 1	1	60

Oil-based dietary supplement	Bio hemp oil	Not available	50	General wellbeing	Increased pulse, agitation, nervousness, shaking, hot feet, unusual feeling	Very likely: 1	1	60
Dietary supplement for infertility	Vitamin E Folic acid Selenium Damiana extract Green tea extract Alicirizine from <i>Glycyrrhiza glabra</i> Diosgenin from yam Omega-3 fatty acids	Not available	28	Infertility	Diarrhoea	Very likely: 1	1	60
Dietary supplement for heart health	Red yeast rice Collagen in powder	Not available	70	Heart health	Urticaria (hives; a raised, itchy rash))	Very, likely: 1	1	60
L-tryptophane (NHCO Nutrition®)	Tryptophan	1 capsule per day	59	Essential amino acid	Headache, nausea	Possible: 1	1	60
Huile Essentielle Menthe Poivrée (Juva Santé®)	Peppermint (essential oil)	2 drops per day	2	Digestive functions	Nausea	Likely: 1	1	60
Alvityl® Vitalité Solution Buvable (Urgo®)	Vitamin A Vitamin B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin C Vitamin D3	1 capsule per day	3	General wellbeing (children)	Cough	Likely: 1	1	60

	Vitamin E							
Propex® Sirop Fluidity (Ortis®)	<i>Sambucus nigra</i> L. Propolis <i>Eucalyptus globulus</i> Labill. <i>Thymus vulgaris</i> L. <i>Pinus sylvestris</i> L. <i>Eucalyptus radiata</i> ssp <i>radiata cineolifera</i> essential oil	15 millilitres 3 times per day	2.5	Respiratory (breathing or lung-related) wellbeing	Abdominal pain	Possible: 1	1	60
Slim Metabol® (Zuccari®)	<i>Olea europaea</i> L. <i>Hibiscus sabdariffa</i> L. Dextrins (fibre) <i>Garcinia cambogia</i> <i>Oryza sativa</i> L. <i>Monascus purpureus</i> Marine collagen (fish) <i>Rheum palmatum</i> L. <i>Cola acuminata</i> Schott. <i>Moringa oleifera</i> Lamk. <i>Opuntia ficus indica</i> Mill.	Not available	71	Metabolic function	Acute hepatitis and death	Likely: 1	1	60

	<i>Cassia mimosoides</i> L. var. nomame Makino <i>Commiphora mukul</i> /Hook <i>Plectranthus barbatus</i> Andrews <i>Coffea arabica</i> L. <i>Crataegus oxyacantha</i> Auct. <i>Cyclantera pedata</i> Schard <i>Lentinula edodes</i> (Berk.) Pegler <i>Orthosiphon stamineus</i> Benth. <i>Rhodiola rosea</i> L. <i>Eleutherococcus senticosus</i> Maxim. <i>Ribes nigrum</i> L. <i>Aristotelia chilensis</i> Magnesium Zinc Chromium Zinc							
Dietary supplement containing 5-alpha-hydroxy laxogenin	5-alpha-hydroxy laxogenin	Not available	33	Not available	Aggression, memory and concentration problems	Likely: 1	1	61

Dietary supplement with lutein	Lutein	Not available	41	Not available	Body rash	Likely: 1	1	61
Dietary supplement for pregnant women or planning a pregnancy	Vitamins and minerals	Not available	25	Pre-conception / Pregnancy	Abdominal cramps, abdominal pain, flatulence	Likely: 1	1	61
Dietary supplement for infertility	Vitamin E Folic acid Selenium Damiana extract Green tea extract Alicirizine from <i>Glycyrrhiza glabra</i> Diosgenin from yam Omega-3 fatty acids	Not available	39	Infertility	Diarrhoea	Very likely: 1	1	61
Dietary supplement for wellbeing	Ayurvedic remedies: Triphala (haritaki, bibhitaki and amla) Yashtimandu Ashwaghanda Kanchanara	Not available	44	General wellbeing	Acute hepatic failure with increase in bilirubin	Very likely: 1	1	61
Dietary supplement containing <i>Plantago psyllium</i>	<i>Plantago psyllium</i>	Not available		Digestive functions	Bone pain, foggy vision, inflammation of the gastric mucosa (stomach lining) and other problems in the digestive system, fatigue, worse concentration,	Less likely in relation to a single ingredient Likely if harmful pollutants such	1	61

					yellowing of the oral (mouth) cavity, the presence of toxic elements in the blood	as toxic elements, mycotoxins (toxic fungi) present		
Dietary supplement containing <i>Silybum marianum</i>	<i>Silybum marianum</i>	Not available	44	Probiotic for digestive functions	Urticaria	Likely: 1	1	61
Food supplement for heart health	Coenzyme Q10	Not available	77	Heart health	Heart rhythm disorders	Very likely: 1	1	61
Microbiane® Q10 (Pileje®)	Coenzyme Q10 Vitamin E Maize starch Magnesium starch Monoglycerides and diglycerides of fatty acids <i>Bambusa arundinacea</i>	1 capsule per day	73	Antioxidant properties	Increased internationalised normalised ratio ("INR", used to check blood clotting problems)	Possible: 1	1	61
Novalac AR® 0-6 Mois (Novalac®)	Skimmed milk Palm oil Coconut oil Soybean oil Magnesium oxide Inositol Lactose Maize starch Soya lecithin Vitamin A Vitamin B1	Not available	Below 1	Baby formula	Diarrhoea, vomiting	Likely: 1	1	61

	Vitamin B2 Vitamin B3 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin B12 Vitamin C Vitamin D3 Vitamin E Vitamin K1 Tripotassium citrate Cystine Choline bitartrate Taurine Manganese sulphate Copper sulphate Zinc sulphate Iron sulphate Sodium selenite Tricalcium phosphate							
Harpagophytum Bio	<i>Harpagophytum</i>	Not available	75	Anti-inflammatory properties	Facial redness	Likely: 1	1	61
Phytophanère® (Phyto®)	Vitamin C Vitamin E Vitamin B2 Vitamin B6 Vitamin B8 Vitamin B5 Zinc Fish oil	1 capsule per day	25	Hair, nails and skin health	Nausea, abdominal pain, constipation	Likely: 1	1	61

	Soy oil Rice bran oil Wheat germ oil Borage oil							
C Biane® Acerola (Pileje®)	<i>Malpighia glabra punicifolia</i>	1 capsule per day	26	Immune function	Migraine	Likely: 1	1	61
Red yeast rice	<i>Monascus purpureus</i>	Not available	58	Not available	Myalgia (muscle pain), increased creatine phosphokinase ("CPK", which can indicate muscle damage)	Likely: 1	1	61
Dietary supplement with magnesium and vitamin B6	Magnesium Vitamin B6	Not available	65	Not available	Flatulence, abdominal cramps	Likely: 1	1	61
Dietary supplement for support of sleep	<i>Valeriana officinalis</i> L. and other herbs	Not available	59	Sleep	Excitation, nausea, blurred vision	Likely: 1	1	62
Yoghurt with chia seeds	Chia seeds	Not available	Not reported	Not available	Allergic reaction	Very likely: 1	1	62
Dietary supplement with colloidal silver	Colloidal silver	Not available	39	Not available	Tremor, forgetfulness, confusion, argyria (bluish skin)	Very likely: 1	1	62
Animal Stak® (Universal Nutrition®)	Pro-testosterone complex	Not available	30	Athletic performance	Liver failure	Not reported	1	62
Animal Rage XL® (Universal Nutrition®)	-	Not available	25	Athletic performance	Heart attack	Not reported	1	62
BCAA Zero® (BioTech USA®)	Leucin Isoleucin Valin Glutamin Vitamin B6	Not available	32	Sport enhancement	Hepatitis	Very likely: 1	1	63

Appétit® Solution Buvable (Gifrer®)	<i>Gentiana lutea</i> <i>Trigonella foenum-graecum</i> <i>Zingiber officinale</i> Potassium sorbate	15 millilitres (1 tablespoon) per day	48	To help those with a poor appetite	Muscle cramps	Possible	1	64
Silicium Organique (Dexsil®)	<i>Urtica dioica</i> Silicic acid Phosphoric acid	15 millilitres per day	39	Joint health	Pruritus, erythema, oedema	Likely	1	64
Spiruline de Grasse en Brindilles (Azur Naturel®)	<i>Spirulina platensis</i>	Not available	Below 1	Herbal supplement	Eczema, hives	Possible	1	64
Vitascorbol® Boost (Cooper®)	Vitamin C Vitamin B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin B12 Copper Magnesium Iron Zinc Molybdenum Chromium Guarana <i>Cola nitida</i> Caffein	1 capsule per day	19	Energy “boost”	Vomiting	Likely	1	65
Duab® (Granions®)	Propolis	1 capsule per day	86	Urinary function	Dizziness	Likely: 1	1	65

	<i>Vaccinium macrocarpon</i> Zinc Calcium Magnesium Menthol Stearic acid							
Sériane® Jour (Naturactive®)	<i>Rhodiola rosea</i> L. Magnesium Zinc Vitamin B6 Milk protein hydrolysate	2 capsules per day	63	Stress control	Headache	Likely	1	65
Gynefam® Plus (Effik®)	Fish oil Coconut oil Palm oil Sunflower oil Vitamin B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B8 Vitamin B9 Vitamin B12 Vitamin D Vitamin E Copper Iron Iodine Magnesium Manganese Selenium Zinc	1 capsule per day	3	Pre-conception	Abdominal pain	Likely: 1	1	66

Pediakid® Sommeil (Ineldea®)	Acacia Agave syrup <i>Citrus sinensis</i> <i>Lavendula officinalis</i> <i>Matricaria chamomilla</i> <i>Melissa officinalis</i> <i>Origanum majorana</i> <i>Crataegus monogyna</i> Cherry juice Magnesium Manganese Sodium Potassium	1 teaspoon per day	Below 2	Sleep quality	Vomiting	Possible: 1	1	66
Calmosine® Allaitement (Laudavie®)	<i>Trigonella foenum-graecum</i> <i>Passiflora incarnata</i> <i>Rosa canina</i> Vitamin B8	10 millilitres 2 times per day	Below 1 month	Breastfeeding support	Vomiting	Likely: 1	1	66
Colonrenove® (LPK®)	Ispaghul <i>Lactobacillus bulgaricus</i> <i>Lactobacillus acidophilus</i> <i>Lactobacillus lactis</i> <i>Lactobacillus casei</i>	Not available	87	Not available	Acute pulmonary oedema (fluid in the lungs)	Likely: 1	1	66

	<i>Streptococcus thermophilus</i> Inulin Glutamine <i>Aloe vera</i> <i>Taraxacum officinale</i> <i>Arctium lappa</i> <i>Fumaria officinalis</i> <i>Cynara scolymus</i> Curcuma Papain							
Prostamol® (Menarini® Nutrition, Hygiene and Health)	<i>Serenoa repens</i>	1 capsule per day	76	Urinary function	Urinary retention	Possible: 1	1	66
Reine des Près Fleurs (L'Herbier de France®)	<i>Spiraea ulmaria</i>	Not available	36	Herbal tea	Epistaxis (nosebleed), menorrhagia (heavy or prolonged menstrual bleeding; life threatening case)	Likely: 1	1	67
Olioseptil® Voies Urinaires (Ineldea®)	<i>Satureja montana</i> essential oil <i>Melaleuca cajuputi</i> essential oil <i>Anethum graveolens</i> essential oil	1 capsule 3 times per day for 5 days	Not reported	Urinary function	Metrorrhagia (irregular periods or bleeding between periods)	Likely: 1	1	67

	<i>Rosmarinus officinalis</i> essential oil <i>Juniperus communis</i> essential oil <i>Eugenia caryophyllus</i> essential oil <i>Melaleuca alternifolia</i> essential oil Olive oil							
Max Robust Xtreme® (Spring Life®)	L-arginine	Not available	64	Sport enhancement	Acute pancreatitis (inflammation of the pancreas)	Likely: 1	1	67
Arkorelax® Sommeil (Arkopharma®)	<i>Passiflora incarnata</i> <i>Valeriana officinalis</i> <i>Melissa officinalis</i> <i>Humulus lupulus</i> Melatonin <i>Eschscholzia californica</i> Vitamin B6	1 capsule per day	73	Sleep and stress	Hypertension	Likely: 1	1	67
Urofyt® (Farmafyt®)	Quercetin <i>Serenoa repens</i> Vitamin C Papain Bromelain	Not available	Not reported	Not available	Skin allergy, pruritus	Not reported	1	67

Curcumina® Plus 95% Piperina & Vitamine B1 B2 B6 (K-line®)	Curcuminoids Piperine Vitamin B1 Vitamin B2 Vitamin B6	2 capsules 2 times per day	Not reported	Gastric and cognitive functions	Acute hepatitis	Not reported	1	67
LiponixX® (ixX Pharma®)	Alpha lipoic acid	1 capsule per day	Not reported	Antioxidant	Tingling	Not reported	1	67
Flexofytol® Plus (Tilman®)	Vitamin D3 <i>Curcuma longa</i> <i>Boswellia serrata</i>	2 to 4 capsules per day	Not reported	Joint health	Allergy (hives, pruritus, oedema and so on)	Not reported	1	67
Huile de Nigelle Bio (De Saint Hilaire®)	<i>Nigella sativa</i> oil	Not available	19	Hair and skin health	Abdominal pain and nausea	Possible: 1	1	68
Pédiakid® 22 Vitamines et Oligo-éléments (Ineldea®)	Carrots Watercress Spinach Beet Vitamin C Vitamin B3 Vitamin E Vitamin B5 Beta carotene Vitamin B6 Vitamin B2 Vitamin B1 Vitamin B9 Vitamin B8 Vitamin D Vitamin B12 Iron Manganese Copper Zinc Potassium	1 teaspoon 2 times per day	3	General health and wellbeing (children)	Diarrhoea	Possible: 1	1	68

	Iodine Molybdenum Selenium Chromium							
Lipocuts Xtreme® (Matador®)	Vitamin B3 Vitamin B6 Bitter orange White willow bark Panax ginseng Caffeine Tetra-decythioacetic acid Capsicum Cinnamon bark <i>Cassia nomane</i> Chromium	1 capsule per day	28	Fat burning (sport enhancement)	Discomfort	Likely: 1	1	68
Mag 2® Cacao Comprimés à Croquer (Cooper®)	Magnesium Cocoa	2 to 6 capsules per day	4	Fatigue	Diarrhoea	Likely: 1	1	68
Life Extension Mix™ Capsules (Life Extension®)	Vitamin A Vitamin C Vitamin D3 Vitamin E Vitamin B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B8 Vitamin B9 Vitamin B12 Calcium	12 capsules per day	40	General health and wellbeing	Nausea and excessive sweating	Possible: 1	1	68

	Iodine Magnesium Zinc Selenium Copper Manganese Chromium Molybdenum Potassium Boron Broccoli N-acetyl-L-cysteine Green tea Acerola Inositol Bitter orange citrus European elder Blackberry Blueberry Sweet cherry Cranberry Plum Persimmon Taurine Ashwagandha Silymarin Trimethylglycine Sour cherry Pomegranate Bilberry Grape proanthocyanidin						
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	Quercetin Bromelain Lutein Olive Sesame seed Luteolin Apigenin Lycopene Delphinidins Cyanidin-3-glucoside							
Arkogélules® Chrysanthellum (Arkopharma®)	<i>Chrysanthellum indicum</i>	3 capsules per day	83	Bones and joints	Hepatitis	Very likely: 1	1	68
Arkogélules® Ispaghul Mucivilat (Arkopharma®)	<i>Plantago ovata</i> Forssk.	3 capsules per day	83	Bones and joints	Hepatitis	Very likely: 1	1	68
Arkogélules® Prêle (Arkopharma®)	<i>Equisetum arvense</i>	3 capsules per day	83	Bones and joints	Hepatitis	Very likely: 1	1	68
Gelée d'Aloe Vera (Lily of the Desert®)	<i>Aloe vera</i>	30 millilitres per day	62	Digestive functions	Nausea	Possible: 1	1	68
Gallia® Calisma® 1 (Gallia)	Milk Palm oil Coconut oil Colza oil Sunflower oil Fish oil <i>Mortierella alpina</i> Soy Inositol	Not available	Below 1	Baby formula	Hives, lip oedema	Likely: 1	1	69

	Taurine Nucleotides L-tryptophan L-carnitine Vitamin A Vita®min B1 Vitamin B2 Vitamin B3 Vitamin B5 Vitamin B6 Vitamin B8 Vitamin B9 Vitamin B12 Vitamin C Vitamin D3 Vitamin E Vitamin K1 Potassium Sodium Calcium Manganese Zinc Copper Iron Magnesium							
Granions® Décontractant Musculaire (Granions®)	Magnesium Potassium Copper Sodium Selenium Vitamin B1 Vitamin B6 Vitamin B12	2 capsules per day	73	Muscle support	Hypotension (low blood pressure)	Likely: 1	1	69

Levure de Riz Rouge® (Santé Verte®)	<i>Monascus purpureus</i> <i>Cynara scolymus</i> <i>Saccharum officinarum</i> Coenzyme Q10 Vitamin E	1 to 4 capsules per day	72	Maintenance of cholesterol	Increased transaminases and CPK	Likely: 1	1	69
Phytosun Arôms® Huile Essentielle de Cannelle Ceylan (Oméga Pharma®)	<i>Cinnamomum zeylanicum</i> essential oil	1 drop 2 times per day	53	Not available	Burn	Possible: 1	1	69
Stovir® (Herbaethic®)	<i>Echinacea angustifolia</i> <i>Sambucus nigra</i> <i>Cinnamomum camphora</i> essential oil <i>Melaleuca alternifolia</i> essential oil <i>Cinnamomum verum</i> <i>zeylanicum</i> essential oil, <i>Syzygium aromaticum</i> essential oil	1 capsule per day for 20 days	63	Immunity	Increased cancer antigen 19-9 (“CA19-9”, which can indicate pancreatic cancer)	Likely: 1	1	69

33 Burn® (Galvanize Nutrition®)	<i>Garcinia cambogia</i> <i>Coffea robusta</i> <i>Paullinia cupana</i> Panax ginseng <i>Camellia sinensis</i> <i>Beta vulgaris</i> <i>Ilex paraguariensis</i> <i>Momordica charantia</i> <i>Cinnamomum cassia</i> <i>Petroselinum crispum</i> <i>Cola acuminata</i> <i>Ginkgo biloba</i> <i>Curcuma longa</i> <i>Zingiber officinale</i> <i>Vitis vinifera</i> <i>Piper nigrum</i> <i>Coleus forskohlii</i> Chitosan L-phénylalanine L-choline L-methionine L-carnitine L-taurine L-tyrosine L-histidine Inositol	2 capsules 2 times per day	22	Weight management	Increased transaminases	Possible: 1	1	69
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N.O.-Xplode® (BSN®)	L-arginine L-lysine L-glycine L-tyrosine Taurine L-phenylalanine Creatine Beta-alanine Inositol Betaine Choline Beetroot Caffeine Vitamin C Vitamin D Vitamin B1 Vitamin B6 Vitamin B9 Vitamin B12 Vitamin B3 Vitamin B5 <i>Vitis vinifera</i> <i>Piper nigrum</i> Amla	Not available	42	Sport enhancement	Amnesia (memory loss), aesthenia (weakness), headache, motor deficit (loss of connection between the central nervous system and the muscles)	Likely: 1	1	69
Kanchanara (Sri Sri Tattva®)	<i>Bauhinia variegata</i>	1 to 2 capsules 2 times per day	59	Liver support and wound healing	Hepatocellular insufficiency (loss of liver function; life threatening case)	Very likely: 1	1	69
Calmosine® Allaitement (Laudavie®)	<i>Trigonella foenum-graecum</i> <i>Passiflora incarnata</i> <i>Rosa canina</i> Vitamin B8	10 millilitres 2 times per day	Below 1	Breastfeeding support	Diarrhoea	Likely: 1	1	70

Phytophanère® (Phyto®)	Vitamin C Vitamin E Vitamin B2 Vitamin B6 Vitamin B8 Vitamin B5 Zinc Fish oil Soy oil Rice bran oil Wheat germ oil Borage oil	Not available	41	Hair growth	Epigastric pain (in the upper abdomen, below the ribs)	Likely: 1	1	70
Magnésium 300+ (Boiron®)	Magnesium Selenium Vitamin B3 Vitamin E Vitamin B5 Vitamin B6 Vitamin B2 Vitamin B1 Vitamin B9 Vitamin B8 Vitamin B12	2 capsules 2 times per day	15	Fatigue	Nausea and abdominal pain	Likely: 1	1	70
Sédivitax® (Aboca®)	<i>Passiflora incarnata</i> <i>Valeriana officinalis</i> <i>Melissa officinalis</i> <i>Eschscholzia californica</i> <i>Valeriana officinalis</i>	2 to 3 capsules per day	81	Support sleep	Agitation	Possible: 1	1	70

	<i>Majorana hortensis</i> essential oil <i>Lavandula angustifolia</i> essential oil							
Mélatonine Valériane Sommeil (Vitarmonyl®)	<i>Valeriana officinalis</i> Melatonin	1 capsule per day	15	Sleep quality	Aesthenia	Possible: 1	1	70
Probiolog® (Mayoli Spindler®)	<i>Lactobacillus acidophilus</i> <i>Bifidobacterium lactis</i>	1 capsule per day	74	Gut health	Diarrhoea and abdominal pain	Likely: 1	1	70
Noopept® (Pure Nootropics®)	N-phenylacetyl-L-prolylglycine ethyl ester	Not available	19	Not available	Nausea and dizziness	Possible: 1	1	70
Premium Fish Oil Omega 3 (Ocean's Essential®)	Fish oil Vitamin E	1 capsule per day	38	Functioning of the cardiovascular system, the brain, and the maintenance of healthy vital functions including sight	Urticaria	Possible: 1	1	70
Vitamin'™22 Specific femme (Ineldea®)	<i>Lactobacillus rhamnosus</i> <i>Lactobacillus acidophilus</i> <i>Punica granatum</i> Panax ginseng CA Meyer	2 capsules per day	39	Female health, including anti-fatigue, women's nutritional needs,	Acute pancreatitis	Likely: 1	1	71

	L-lysine L-tryptophan Beta carotene Vitamin C Vitamin D Vitamin E Vitamin B6 Vitamin B9 Vitamin B12 Vitamin K Calcium Magnesium Iron Chromium Manganese Boron			preserves bone capital, good nervous system function, helps stimulate cognitive processes and maximises protection against oxidation and ageing				
Essential Omega-3 (Myvitamins®)	Fish oil	1 capsule per day	46	Healthy heart	Cerebellar intraparenchymal haematoma (bleeding in the brain)	Likely: 1	1	71
Capsule Origan+® (Pranarôm®)	<i>Origanum vulgare</i> <i>Citrus limon</i>	2 capsules 3 times per day for 5 to 7 consecutive days	Not reported	Support immune system	Nausea, vomiting and diarrhoea	Possible: 1	1	71
Curcumine (Pure-Santé®)	Curcumin	Not available	79	Not available	Haemorrhoids	Possible: 1	1	71

Qualitative elicitation study – Focus groups

Focus group demographics and participant characteristics

Four online focus groups were conducted (Table 9) with 39 participants (Table 10).

A total of 27 participants were current supplements users and 13 participants were not.

Table 9 Focus group demographics in a study exploring food supplements use among adults on the island of Ireland

Group (and number of participants)	Location	County (and number of participants)	Age range in years (and mean age)	Males	Females	Living in urban location	Living in rural location
Group 1 (10)	Ireland	Sligo (2) Kildare (2) Dublin (2) Galway (1) Louth (1) Tipperary (1) Roscommon (1)	24 to 68 (46.0)	3	7	4	6
Group 2 (9)	Northern Ireland	Antrim (2) Down (1) Tyrone (2) Derry (4)	28 to 52 (39.3)	1	8	3	6
Group 3 (10)	Ireland	Sligo (1) Donegal (3) Clare (1) Mayo (1) Galway (1) Cork (2) Waterford (1)	24 to 58 (40.6)	4	6	2	8
Group 4 (10)	Northern Ireland	Armagh (1) Antrim (2) Derry (6) Tyrone (1)	19 to 56 (34.6)	6	4	5	5

Table 10 Focus group participants' self-reported characteristics (as selected from set multiple choice options) in a study exploring food supplements use among adults on the island of Ireland

Participant characteristic	Category	Number of participants	Percentage per characteristic and category
Average age of participants 40.2 years, SD 13.1			
Gender	Male	15	38.4
	Female	24	61.5
Country	Northern Ireland	19	48.7
	Ireland	20	51.3
Area of residence	Rural	25	64.1
	Urban	14	35.9
Education: highest level achieved	School to 15 or 16 years	1	2.6
	School or college to 17 or 18 years	13	33.3
	Undergraduate	13	33.3
	Postgraduate	12	30.8
Working status	Full time	20	51.3
	Part time	8	20.5
	Retired	3	7.7
	Student in school or third level	1	2.6
	Self-employed	4	10.3
	Unemployed	2	5.1
	Other (Carer)	1	2.6
Marital status	Married or living as if married	21	53.8
	Single	16	41.0
	Divorced or separated	2	5.1
Health status	Generally healthy	30	76.9
	Quite healthy	7	17.9
	Active	21	53.8
Which of the following apply?	Living with a physical health condition	2	5.1
	Living with a mental health condition	4	10.3
	Breastfeeding	2	5.1
	Vegetarian	3	7.7
	Vegan	1	2.6
	Other special diet	1	2.6

Data from focus group participants

Across all 4 focus groups, the top 3 forms of food supplements commonly referred to during discussions were “tablets or capsules”, “sachets or powders” and “shakes or drinks”.

A summative content analysis (that is, counting how many times particular keywords are mentioned in discussions and drawing conclusions from this) was also reported for the types of food supplements that featured throughout discussions, and it was evident that the term “vitamin(s)” or “multivitamin” was used interchangeably for food supplements by many:

“I would always think ‘vitamins’ whenever I hear ‘food supplements’, automatically.”

“I don’t take any supplements or anything like that ... I haven’t really thought about it too much ... I haven’t realised you could just walk out and you could just buy these vitamins.”

“I’ve taken kind of supplements and vitamins for years on and off.”

The top 50 per cent of types of food supplements frequently mentioned by focus group participants were used as answer categories for relevant questions in the quantitative survey. These were

- Multivitamin or multimineral
- Vitamin D
- Vitamin C
- Iron
- Protein
- B vitamin(s) or B complex
- Vitamin B12 injection
- Fish oils or omega-3
- Magnesium
- Other sport or performance-related supplement
- Folic acid
- Glucosamine sulphate
- Electrolytes or rehydration supplement

In food supplements users, taking more than 1 type of supplementation was also apparent:

“I take, uhm, I'd say nearly 10 supplements every day ... it's a handful, I take loads.”

“I've actually started taking some extra ones.”

“Like, we take multivitamins and whole vitamin D with it.”

There were mixed opinions about the definition of “food supplements” presented during each group. For some, there was a pre-existing awareness or broad agreement around what a food supplement *is* but the opposite was true for others:

“I think the definition is fairly comprehensive, like. I think it covers everything, really, like. I'd agree with it.”

“According to the definition they probably are supplements but didn't really consider them to be supplements or minerals, you know.”

Themes identified from the qualitative data are presented in the context of the Theory of Planned Behaviour constructs and evidenced (supported) by example quotes for behavioural, normative and control beliefs across all focus groups in Table 11, Table 12 and Table 13.

Table 11 Themes that identify perceived advantages and disadvantages of food supplements use, related to Theory of Planned Behaviour measured construct of “behavioural beliefs” with supporting examples of quotes from some of the 39 focus group participants (food supplements users and non-users) in a qualitative elicitation study exploring food supplements use among adults on the island of Ireland

Theory of Planned Behavioural construct:	Behavioural beliefs	Example quotes
<u>Perceived advantages</u>		
Replaces anything lacking in the diet		<p><i>"I take a lot of my supplements because I don't think that I get enough from my diet ... plates of food are beige and, em [laughs], and there's not 3 different vegetables and the kids aren't eating 5 pieces of fruit a day."</i></p> <p><i>"If I, say, if you're not getting enough vitamin D or vitamin C, whatever, then it's the easiest way."</i></p> <p><i>"Sometimes you can't always, or people can't always eat or have access to the diet that they would like. Uhm, or maybe economically or for other reasons, lifestyle choices, all sorts of reasons, so in that case I think that it's probably really helpful and good to use supplements."</i></p>
Perceived benefit or prevent ill health		<p><i>"One's to stop you from getting something you don't want to get and ones to take if you got something"</i></p> <p><i>"To keep you healthy."</i></p> <p><i>"It's supposed to benefit you and I do notice if I haven't taken that I'd feel more tired and stuff, so it does benefit me."</i></p>
Benefit joints		<p><i>"I take turmeric and collagen, uhm, and I have cartilage wearings in my hips, so that's why I take that ... just the anti-inflammatory effects, and I was just kind of like willing to try anything that might help ... for, like, inflammatory pain."</i></p> <p><i>"Omega 3 and vitamin D I've started taking to try and help my joints and stuff cause my knees are a bit dodgy so just because my habits are changing."</i></p> <p><i>"I would read something to suggest if it's good for your joints so I'd maybe jump on that for a while ... so I wouldn't hurt my joints."</i></p>
Support the immune system		<p><i>"If I feel a bit of a cold coming on I take one of those Vitamin C, zinc tablets, emm, for a while now, I've been bad at taking them as well but if I do feel a cold coming along, I'll take it."</i></p> <p><i>"Helps your immune system."</i></p>

Protect against COVID-19	<i>"I see a lot online about vitamin D and COVID, that it's supposed to help COVID."</i> <i>"Would be influenced to start taking it [multivitamins with iron] regularly again because of COVID."</i>
Support for exercise or sport	<i>"So, my experience with food supplements is just to top up your diet when your body's under stress."</i> <i>"Creatine, would have taken whey protein, I would have taken, ehh ... anything, anything that was kind of beneficial towards sport, I would have taken it."</i>

Perceived disadvantages

Lack of effect	<i>"I think a lot of the time it over-promises what it says it's going to do. I mean, em, it might say it does this this and this and you don't actually see the effects of that from taking that."</i> <i>"You don't know whether it's going to work, you don't know how much of it you absorb."</i>
Cost	<i>"The cost is probably a disadvantage to [me], like, you know, they can be expensive if you are using them a lot."</i> <i>"Definitely the cost."</i>

Table 12 Themes that identify “people who approve” and “do not approve” of food supplements use, related to Theory of Planned Behaviour measured construct of “normative beliefs” with supporting examples of quotes from some of the 39 focus group participants (food supplements users and non-users) in a qualitative elicitation study exploring food supplements use among adults on the island of Ireland

Theory of Planned Behaviour construct:	
Normative beliefs	Example quotes
<u>People who approve</u>	
Health professionals	<i>"My GP [General Practitioner, medical doctor] just offered things and certain things that might help."</i> <i>"You're advised by the health visitors and stuff to take things if you're breastfeeding, uhm, so that's for vitamin D, really."</i>

Family	<p><i>"I mean, my Mum mainly told me, like, she was very wary of me going veggie ... she would have been very, like, emm, 'You need watch your iron ... B12 intake, as well', so my education really came from my Mum."</i></p>
Other supplements users	<p><i>"I was talking to my brother-in-law ... and he was able to say, 'Have you tried taking such-and-such', you know ... if it works for somebody then you might think it will work for you. Em, that would be what would kind of influence me."</i></p>
Celebrities or influencers	<p><i>"People just taking vitamins because they hear about other people taking them, read about them."</i></p>
Other people	<p><i>"I suppose I can [named online search engine] it all but I think if it comes from a recommendation or if somebody tells you, 'Yeah, that's working for me', then that would kind of make me buy it more than [named online search engine]."</i></p>
Friends/ peers	<p><i>"I follow quite a lot of vegetarian or vegan influencers on social media or celebrity endorsements."</i></p> <p><i>"Because [a celebrity] was doing it with [a team] so it was kind of the thing to do at the time."</i></p> <p><i>"When it's, like, supplements are mentioned or when someone says to me, 'Oh, you should start taking this', it does make me think."</i></p> <p><i>"Getting recommended by different people."</i></p> <p><i>"A friend of mine said recently that, em, magnesium is meant to be good for migraines and ... because I get migraines, I was like, 'Ohhhh I wonder should I start taking that?'"</i></p> <p><i>"Something a friend told them."</i></p>

People who do not approve

The older generation and non-users	<p><i>"More old-fashioned people, so, like, people would rather get their nutrition through, you know, actual food instead of, like, filling their bodies with tablets and supplements, like, that sort of way."</i></p>
	<p><i>"It would be unusual, it wouldn't be the norm, so there'd be questions, you know. Why are you using them? Is there a benefit?"</i></p>

Table 13 Themes that identify perceived facilitators and barriers to food supplements use, related to Theory of Planned Behaviour measured construct of “control beliefs” with supporting example quotes from some of the 39 focus groups participants (food supplements users and non-users) in a qualitative elicitation study exploring food supplements use among adults on the island of Ireland

Theory of Planned Behaviour construct:	
Control beliefs	Example quotes
<i>Perceived facilitators</i>	
Ability to purchase	<p><i>"I just make sure I buy them off [named health food chain store] and I get them, like, every 2 or 3 months."</i></p> <p><i>"I work in a supermarket on the till ... a lot of them [people] coming in and buying their vitamins, minerals, all them sorts of tablets."</i></p>
Convenience of obtaining information online	<p><i>"You can ... do your own [market] research and [named online search engine] would be your best friend ... Yeah, I would, I would look stuff up on the Internet, yeah. [Named online search engine.]"</i></p> <p><i>"I just look it up online ... I feel like the easiest thing to do is just type it into [named online search engine] [for] what I should be taking."</i></p>
Advertisements	<p><i>"Advertising has a lot to do ... answer for as well. Mainly maybe magazines for women, I think, and they kind of like scaremonger you."</i></p> <p><i>"I know one thing that maybe drives people towards taking vitamins is maybe TV advertising ... it's pretty much a hard sell on television, so that would probably influence people as well, I think."</i></p>
Availability	<p><i>"I recently found a website ... supplements and vitamins not coming from America but they were, like, half the price than what they would be in Irish shops ... getting them online, then, is easier and another benefit of that, then, is that they're a lot cheaper, as well."</i></p> <p><i>"You know, it could be seen as an easy option, you know, and just to take supplements instead of actually putting the effort in to cook yourself a meal or look for healthy ingredients that would give you, umm, the vitamins and minerals you need each day."</i></p>

Particular life stage	<p><i>"Yeah, definitely as I've got older, I've been thinking more about what I should be taking – or what I'm lacking of, more to the point."</i></p> <p><i>"You shouldn't really need to, maybe, but that's maybe at a younger age, I think as we get older, I think our immune systems becomes a bit, uhm, weakened and, yeah, it's a bit of a boost, I think, for us, really."</i></p>
Playing sport or exercising regularly	<p><i>"Playing, like, rugby and sport and stuff, just with the protein shakes and stuff like that, I think, it's an easy way of getting ... nutrition into your body."</i></p> <p><i>"When I'm on the bike, if I'm doing a long spin, you know, if I'm doing 3 or 4 hours on the bike, I'll take those [supplements]."</i></p>
Abnormal result diagnosis	<p><i>"I would always take iron supplements, anyway ... just after having babies and, you know, your blood levels were low."</i></p> <p><i>"If someone was to tell you what your body's deficient in, you know, if you're lacking something after, say, an MOT [or NCT] at the doctor's, they, said you know, we recommend you taking this, that or the other, then you would go and do it."</i></p>

Perceived barriers

Lack of knowledge	<p><i>"If the healthcare professional had told me what strength to take that would have alleviated all of this. If I could have just got the right strength."</i></p> <p><i>"I haven't taken any supplements ... I'm not too sure ... what really works, if I'm honest."</i></p>
Not remembering or not being in the habit	<p><i>"I just forgot to take them ... I'd do good for a few weeks then I'd forgot about them and don't."</i></p> <p><i>"I'll get out of the habit and stop taking them ... I could just fall out of the habit, or I could run out, or maybe I would just get fed up of taking supplements every day."</i></p>

Overall, participants held mainly positive attitudes towards food supplements, with the main perceived advantages being the ability to replace anything lacking in the diet and the perceived benefits general health. Specific health conditions mentioned most commonly included benefits for joint care, immune health and possible protection against COVID-19. The use of food supplements was also associated with the idea of taking control to prevent ill health, as well as providing extra support during times of perceived need, for example when exercising or playing sport. In contrast to the perceived advantages to health, it was acknowledged that some food supplements may have no effect on health, or lack of a measurable effect. The cost of food supplements was also highlighted as a major disadvantage, although not a barrier to their use.

Doctors and a wide range of healthcare professionals (for example health visitors, physiotherapists) were the main group that would approve of food supplements use in some contexts. Family and friends were likely to influence intentions as well as behaviours, particularly when such individuals were also food supplements users and perhaps had positive experiences to share. The influence or endorsement of food supplements from celebrities and social media influencers was also noted, particularly in younger participants. Many participants struggled to identify any individual or group that would disapprove of their use of food supplements, suggesting this may be regarded as a more neutral lifestyle choice. For some, they might have been discouraged in the past by their peers who either were non-users or did not agree with the perceived need to take food supplements. In one group, older adults came out strongly as a negative influence towards intentions to take food supplements, particularly if this was not part of their own upbringing or “the norm” within their household.

Largely aligned with the positive attitudes, many facilitators towards the use of food supplements were highlighted across all groups with a strong consensus (agreement among the participants) for those most frequently discussed. Availability, convenience and accessibility (that is, being able to buy food supplements easily), as well as advertisements, were enabling factors. Certain contexts also appear to influence food supplements use, giving those who take them a sense of control over a perceived need, such as when at a certain stage of life (for example with increasing age or after menopause) or when taking part in sports or exercising regularly. Overall, knowledge and the readiness of information online were also important. Linked to this, being equipped with the knowledge of an abnormal

result from a health check or blood test would also be a strong motivator, if this could be corrected using food supplements. In contrast, being overwhelmed with sometimes conflicting information from a variety of sources may prevent food supplements use for some and a lack of knowledge was also a major barrier across all groups. In general, not remembering to take food supplements or not getting into the habit of consumption was associated with more short-term, irregular or discontinued use.

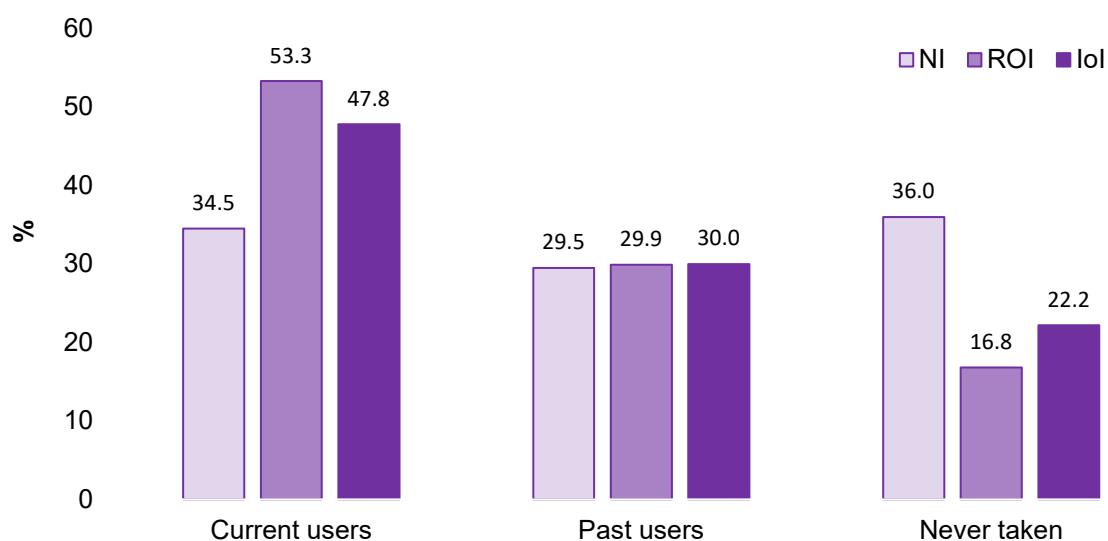
Quantitative study – Survey questionnaire

Survey questionnaire participant demographic characteristics

Demographic characteristics of the 2,000 survey questionnaire participants are shown in Table 14, with key differences reported between current food supplements users (956 participants, or 47.8 per cent of the sample) and non-users (1,044 participants, or 52.2 per cent of the sample).

- “Non-users” includes the 445 survey participants (22.2 per cent of the sample) who reported never taking food supplements and the 601 participants (30.0 per cent of the sample) who had taken food supplements in the past but were not currently taking any (Figure 3).
- Most “past users” reported taking a food supplement in the previous 6 months (12.8 per cent), compared with only 5-7 per cent of the total group reporting food supplements use in the previous 1 to 5 years or more than 5 years ago.

Figure 2 Reported food supplements use in a quantitative survey of 2,000 adults on the island of Ireland.



A significantly higher proportion of food supplements users were female, aged from 35 to 49 years, from Ireland, of higher socioeconomic status, working full time, married or living as married, living with a diagnosed physical health condition, vegetarian or vegan.

Table 14 Survey questionnaire participants' self-reported characteristics (as selected from set multiple choice options) in a quantitative study exploring food supplements use among adults on the island of Ireland

Participant characteristic	Category	Number out of total sample of 2,000 (and percentage of total)	Users n = 956 (and percentage of total sample)	Non-users n = 1,044 (and percentage of total sample)	P-value ^a
Age in years: Mean; standard deviation; range		45.4; 17.2;	45.4; 16.8;	45.5; 17.5;	0.854
Gender	Male	978 (48.9)	399 (20.0)	579 (29.0)	Below 0.001
	Female	1,022 (51.1)	557 (27.9)	465 (23.3)	
	18 to 24	310 (15.5)	126 (6.3)	184 (9.2)	0.001
	25 to 34	324 (16.2)	186 (9.3)	138 (6.9)	

	35 to 49	543 (27.2)	264 (13.2)	279 (14.0)
	50 to 64	449 (22.5)	203 (10.2)	246 (12.3)
	65 and older	374 (18.7)	177 (8.9)	197 (9.9)
Country	Northern Ireland	566 (28.3)	196 (9.8)	370 (18.5)
	Ireland	1,434 (71.7)	760 (38.0)	674 (33.7)
Area	Northern Ireland – Belfast	130 (6.5)	44 (2.2)	86 (4.3)
	Northern Ireland – North	85 (4.3)	29 (1.5)	56 (2.8)
	Northern Ireland – South	204 (10.2)	80 (4.0)	124 (6.2)
	Northern Ireland – West	147 (7.4)	43 (2.2)	104 (5.2)
	Ireland – Dublin	416 (20.8)	226 (11.3)	190 (9.5)
	Ireland – Leinster (outside of Dublin)	387 (19.4)	204 (10.2)	183 (9.2)
	Ireland – Munster	387 (19.4)	204 (10.2)	183 (9.2)
	Ireland – Connacht and Ulster	244 (12.2)	125 (6.3)	119 (5.9)
Main shopper (housekeeper)		1,881 (94.1)	918 (48.8)	963 (51.2)
Socioeconomic status	ABC1	856 (42.8)	462 (23.1)	394 (19.7)
	C2DE	1,143 (57.2)	493 (24.7)	650 (32.5)
Chief income earner		1,301 (65.1)	625 (48.0)	676 (52.0)
Working status	Full time	814 (40.7)	420 (21.0)	394 (19.7)
	Part time	214 (10.7)	108 (5.4)	106 (5.3)
	Housewife (full time)	192 (9.6)	103 (5.2)	89 (4.5)
	Retired	350 (17.5)	153 (7.7)	197 (9.9)
	Student (school or third level)	185 (9.3)	77 (3.9)	108 (5.4)
	Unemployed	244 (12.2)	95 (4.8)	149 (7.5)
Marital Status	Married	947 (47.3)	476 (23.8)	471 (23.5)
	Living as married	223 (11.2)	117 (5.9)	106 (5.3)
	Single	633 (31.7)	273 (13.7)	360 (18.0)
	Widowed, divorced or separated	182 (9.1)	87 (4.4)	95 (4.8)
	Not specified	15 (0.8)	3 (0.2)	12 (0.6)

		Number out of total sample of 2,000 (and percentage)	Number of users reporting specific health or diet status (and percentage of this subgroup)	Number of non-users reporting specific health or diet status (and percentage of this subgroup)	
Perceived health status	Very healthy	345 (17.2)	179 (8.9)	166 (8.3)	
	Fairly healthy	1,362 (68.1)	646 (32.3)	716 (35.8)	
	Fairly unhealthy	261 (13.0)	116 (5.8)	145 (7.2)	
	Very unhealthy	33 (1.6)	15 (0.7)	18 (0.9)	
					0.304
Which of the following apply?	Living with a physical health condition	450 (22.5)	252 (56.0)	198 (44.0)	Below 0.001
	Living with a mental health condition	209 (10.5)	104 (49.8)	105 (50.2)	0.544
	Pregnant	20 (1.0)	11 (55.0)	9 (45.0)	0.517
	Breastfeeding	24 (1.2)	12 (50.0)	12 (50.0)	0.828
	Vegetarian	129 (6.5)	82 (63.6)	47 (36.4)	Below 0.001
	Vegan	50 (2.5)	31 (62.0)	19 (38.0)	0.042
	None of these	1,281 (64.1)	562 (43.9)	719 (56.1)	Below 0.001

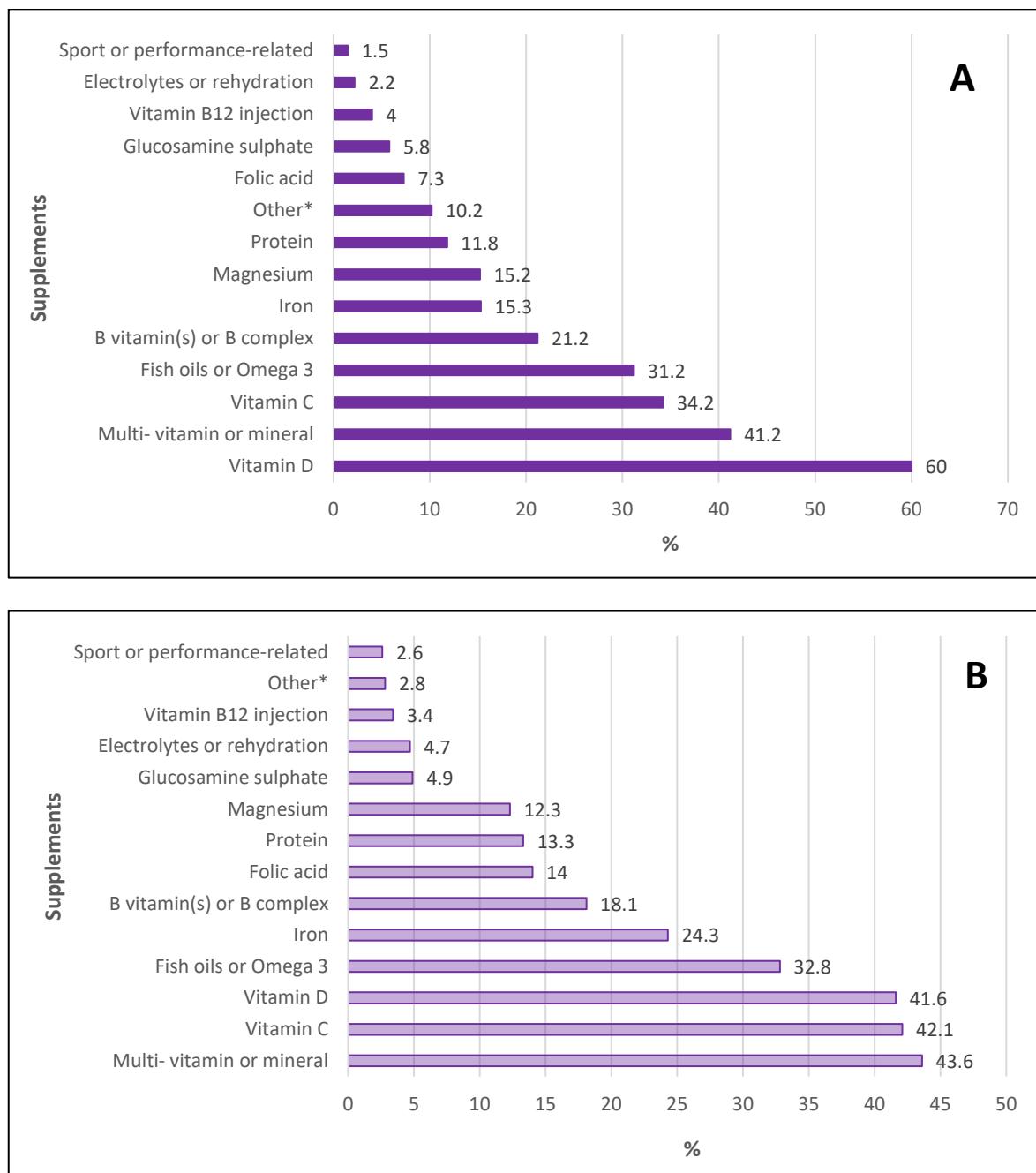
^a Difference between food supplements user and non-user groups; Chi-squared or independent t-test where appropriate, P below 0.05.

Food supplements use behaviour

Food supplements use behaviour among the general population

- In current users, the average number of food supplements reported was 2.6 (SD 1.7; range between 1 and 12 supplements being taken) with more than half of the group (59 per cent) currently taking 1 or 2 food supplements.
- The top 3 food supplements reported by current users were vitamin D, multivitamins or multiminerals and vitamin C (Figure 4).

Figure 3 The types of food supplements used reported by (A) 956 current users and (B) 600 past users in a quantitative survey of 2,000 adults on the island of Ireland



* “Other” category included Specific minerals (for example chromium, calcium, zinc, selenium, iodine); Other vitamins (for example bone and joint vitamin supplements, vitamin E, vitamin K2); Foods (for example chia or flax seeds, garlic, apple cider vinegar, ginger, kefir); Herbal preparations (for example peppermint oil, turmeric, *Echinacea*, *Aloe vera*, cannabidiol or “CBD” drops); Weight loss products (for example raspberry ketones, meal replacement shakes); Probiotic preparations; Coenzyme Q10; L-lysine; Collagen; Evening primrose oil.

- In the majority, participants reported daily consumption of food supplements for the last 6 months, bought by themselves, and most likely from a chemist or pharmacy.
- The popularity of buying in supermarkets, health food shops and through the Internet was similar among those who purchased their food supplements, as was the number reporting the duration of use for each of the timeframe options – from “Within the last month” to “Longer than [3 years ago]” (Table 15).
- Behaviours in terms of the number (mean 2.6; SD 1.6; range 1 to 10) and types of food supplements reported by past users were broadly similar.

Table 15 Pattern of food supplements use behaviour reported by 956 current users in a quantitative survey of 2,000 adults on the island of Ireland

Measure	Behaviour	Number of users reporting this behaviour n = 956 (and percentage of total users)	P-value ^a
Number of food supplements taken:			
Mean; standard deviation; range		2.6; SD 1.7; range 1 to 12	Not applicable
Frequency	Daily	771 (80.6)	
	4 to 5 times per week	110 (11.5)	
	2 to 3 times per week	49 (5.1)	Below 0.001
	Weekly	15 (1.5)	
	Fortnightly	3 (0.3)	
	Monthly	7 (0.7)	
	Less often	2 (0.2)	
Duration	Last month	144 (15.0)	
	Last 6 months	225 (23.5)	
	Last year	209 (21.9)	0.001
	Last 2 to 3 years	189 (19.8)	
	Longer than this	189 (19.8)	
Context	On prescription	80 (8.3)	Below 0.001
	I buy these myself	830 (86.8)	
	Combination	46 (4.8)	
Measure	Behaviour	Number of users who selected “I	P-value

		buy these myself” or “Combination” n = 876 (and percentage of this subgroup)
Purchased from	Chemist or pharmacy	328 (37.4)
	Health food shop	171 (19.5)
	Supermarket	220 (25.1)
	Local shop	21 (2.3)
	Internet	137 (15.6)

^a Significant difference between response categories. (Chi-squared test used; P below 0.01.)

Food supplements use behaviour among subgroups of interest – older people, women of childbearing age or pregnant or breastfeeding, and vegetarians and vegans

An overview of food supplements use in subgroups of interest – older people, women of childbearing age or who are pregnant or breastfeeding, and vegetarians and vegans – is provided in Table 16.

- The proportion of older adults (aged 65 years and above) and women of childbearing age (18 to 49 years old) or those pregnant or breastfeeding who reported current food supplements use was broadly similar to the total cohort, with around half of adults reporting current use in these subgroups.
- The proportion of vegetarians and vegans reporting current food supplements use was slightly higher (63.3 per cent and 62.1 per cent, respectively).

Table 16 Overview of food supplements use behaviour in subgroups of interest – older people, women of childbearing age or who are pregnant or breastfeeding, and vegetarians and vegans – in a quantitative survey of 2,000 adults on the island of Ireland

Measure	Behaviour	65 years and above n = 374 (and percentage of subgroup)	Women of childbearing age ^a n = 710 (and percentage of subgroup)	Pregnant n = 19 (and percentage of subgroup)	Breastfeeding n = 24 (and percentage of subgroup)	Vegetarian n = 129 (and percentage of subgroup)	Vegan n = 50 (and percentage of subgroup)
Food supplements use	Current user	177 (47.3)	375 (52.8)	11 (54.3)	12 (49.8)	82 (63.3)	31 (62.1)
	Past user	84 (22.5)	228 (32.1)	7 (35.5)	10 (41.0)	34 (26.4)	14 (28.1)
	Never used	113 (30.2)	107 (15.0)	2 (10.2)	2 (9.3)	13 (10.3)	5 (9.8)
Supplement type	Top 3 supplements used (and percentage of subgroup)	Vitamin D (70.5) Multivitamin or multimineral (31.4)	Vitamin D (58.6) Multivitamin or multimineral (45.8)	B vitamin(s) (53.6) Iron (45.0)	Vitamin D (69.0) Multivitamin or multimineral (49.2)	Vitamin D (66.8) Vitamin C (44.6) Multivitamin or multimineral (44.2)	Multivitamin or multimineral (56.7) Vitamin D (56.6) Iron (44.3)
	Fish oils (29.7)	Vitamin C (38.4)	Multivitamin or multimineral (43.0)	Vitamin C (45.7)			
Number of supplements taken: Mean; standard deviation; range	2.2; 0.9; 1 to 6	2.9; 2.0; 1 to 12	3.6; 3.2; 1, 4 to 5, 12	3.1; 2.8; 1 to 3, 12	3.2; 2.5; 1 to 6, 8 to 9, 11 to 12	3.4; 2.6; 1 to 5, 8, 12	

<i>Current users only</i>		65 years and above	Women of childbearing age ^a	Pregnant	Breastfeeding	Vegetarian	Vegan
		n = 177 (and percentage of current users subgroup)	n = 375 (and percentage of current users subgroup)	n = 11 (and percentage of current users subgroup)	n = 12 (and percentage of current users subgroup)	n = 82 (and percentage of current users subgroup)	n = 31 (and percentage of current users subgroup)
Frequency of food supplements use	Daily	158 (89.5)	300 (80.0)	8 (76.6)	12 (100.0)	61 (74.4)	24 (77.7)
	4 to 5 times per week	12 (6.9)	38 (10.2)	2 (14.4)	0 (0.0)	12 (15.2)	7 (21.6)
	2 to 3 times per week	2 (1.0)	28 (7.4)	1 (9.0)	0 (0.0)	4 (4.7)	0 (0.7)
	Weekly	3 (1.5)	5 (1.3)	0 (0.0)	0 (0.0)	2 (2.2)	0 (0.0)
	Fortnightly	1 (0.5)	2 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Monthly	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3)	0 (0.0)
	Less often	0 (0.0)	2 (0.5)	0 (0.0)	0 (0.0)	0 (0.6)	0 (0.0)
	Last month	12 (6.7)	86 (22.9)	4 (33.3)	2 (15.5)	19 (22.7)	6 (18.2)
	Last 6 months	29 (16.3)	102 (27.3)	5 (50.7)	2 (19.8)	15 (18.2)	11 (34.4)
Duration	Last year	34 (19.3)	86 (23.0)	1 (7.6)	4 (32.4)	17 (20.9)	5 (17.2)
	Last 2 to 3 years	38 (21.5)	67 (17.8)	0 (0.0)	3 (26.3)	21 (25.7)	5 (17.2)
	Longer than this	64 (36.2)	34 (9.0)	1 (8.4)	1 (6.0)	10 (12.4)	4 (12.9)
	On prescription	24 (13.4)	34 (9.0)	7 (67.0)	3 (21.4)	10 (11.7)	4 (11.8)
Context	I buy these myself	145 (82.0)	318 (84.9)	3 (33.0)	9 (78.6)	69 (84.5)	27 (88.2)
	Combination	8 (4.6)	23 (6.1)	0 (0.0)	0 (0.0)	3 (3.8)	0 (0.0)
	Chemist or pharmacy	68 (44.4)	135 (39.6)	2 (47.3)	5 (51.1)	19 (26.1)	7 (26.1)
	Health food shop	34 (22.0)	66 (19.5)	1 (27.3)	4 (39.6)	24 (33.7)	9 (34.8)
Purchased from ^b	Supermarket	37 (24.4)	78 (23.0)	0 (0.0)	1 (7.6)	19 (26.8)	3 (11.5)
	Local shop	0 (0.0)	13 (3.8)	0 (0.0)	0 (0.0)	3 (4.6)	0 (0.0)
	Internet	14 (9.0)	48 (14.1)	1 (25.4)	0 (1.6)	6 (8.8)	7 (27.6)

^a Women of childbearing age includes all females aged 18 to 49 years.

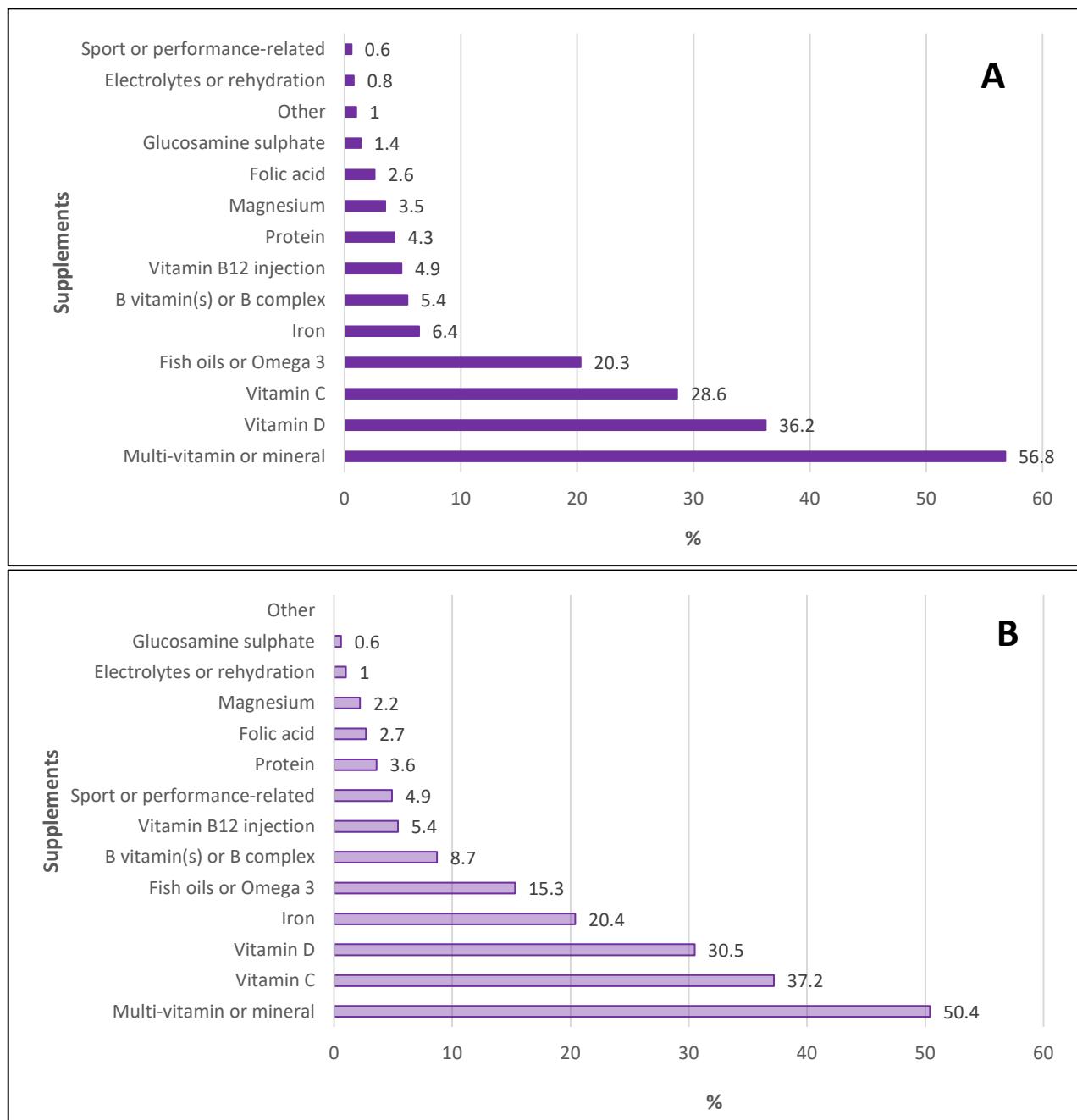
^b Only if "I buy these myself" or "Combination" was selected from the "Context" question above

Food supplements use behaviour among parents or those with a child or children in their care

Parents or those with children in their care (648 participants) reported the following behaviour related to food supplements use for their child or children.

- 303 (46.7 per cent of the subgroup) were currently giving their child or children food supplements (either regularly or irregularly).
- 152 (23.5 per cent) had given their child or children food supplements in the past but are not currently.
- 193 (29.8 per cent) have never given their child food supplements.
- More than half of the parents currently giving their child or children food supplements were only using one type (mean number of 1.7 supplements; SD 1.1; range 1 to 9), most likely a multivitamin or multimineral. Vitamin D and vitamin C were again the second and third most popular choices (Error! Not a valid bookmark self-reference.).
- Parents who were food supplements users themselves were 2.4 times more likely to give their child or children food supplements (Odds ratio, or “OR”, 2.36; 95 per cent confidence interval, or “CI”, 1.55 to 3.58). Being female, having a lower risk or safety “awareness” score and having more positive intentions and attitudes towards food supplements were also significant determinants of parental food supplements use in the most predictive model.

Figure 4 The types of food supplements used as reported by parents or those with children in (A) 303 current users and (B) 152 past users.



Food supplements knowledge and awareness of risk or safety

- Overall knowledge was low, particularly around pre-marketing testing requirements for food supplements; and most had the incorrect perception that packaging for supplements must

contain information on possible adverse effects resulting from their use, with less than 10 per cent of participants answering this item correctly (Figure 5).

- Just under 40 per cent of participants perceived food supplements use to be “risk-free” for the general public.
- The level of consideration and thought given to the use of food supplements was high, with more than two thirds (67 to 81 per cent) agreeing or strongly agreeing that they:
 - ‘Think carefully’ about taking more than 1 supplement at a time
 - ‘Think carefully’ about taking supplements at the same time as taking medication
 - ‘Always’ check the correct dosage.’
- Around 5 to 10 per cent “Disagree” or “Strongly disagree” that they “always check the information on the label to know I am taking the correct dose”, “think carefully about taking food supplements at the same time as medications” and “think carefully about taking more than 1 supplement at a time” (Figure 6).

- Figure 5 Responses to the 6 food supplements “knowledge” items in a quantitative survey of 2,000 adults on the island of Ireland.

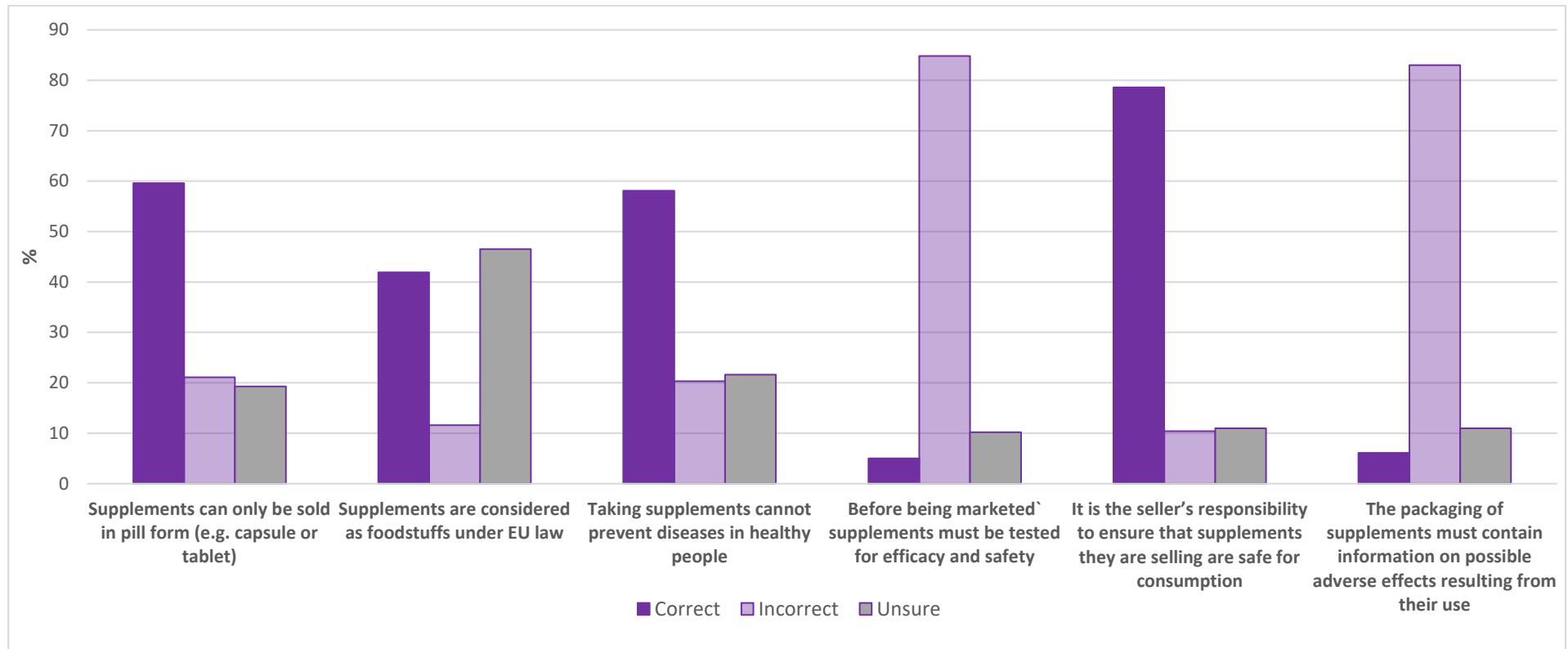
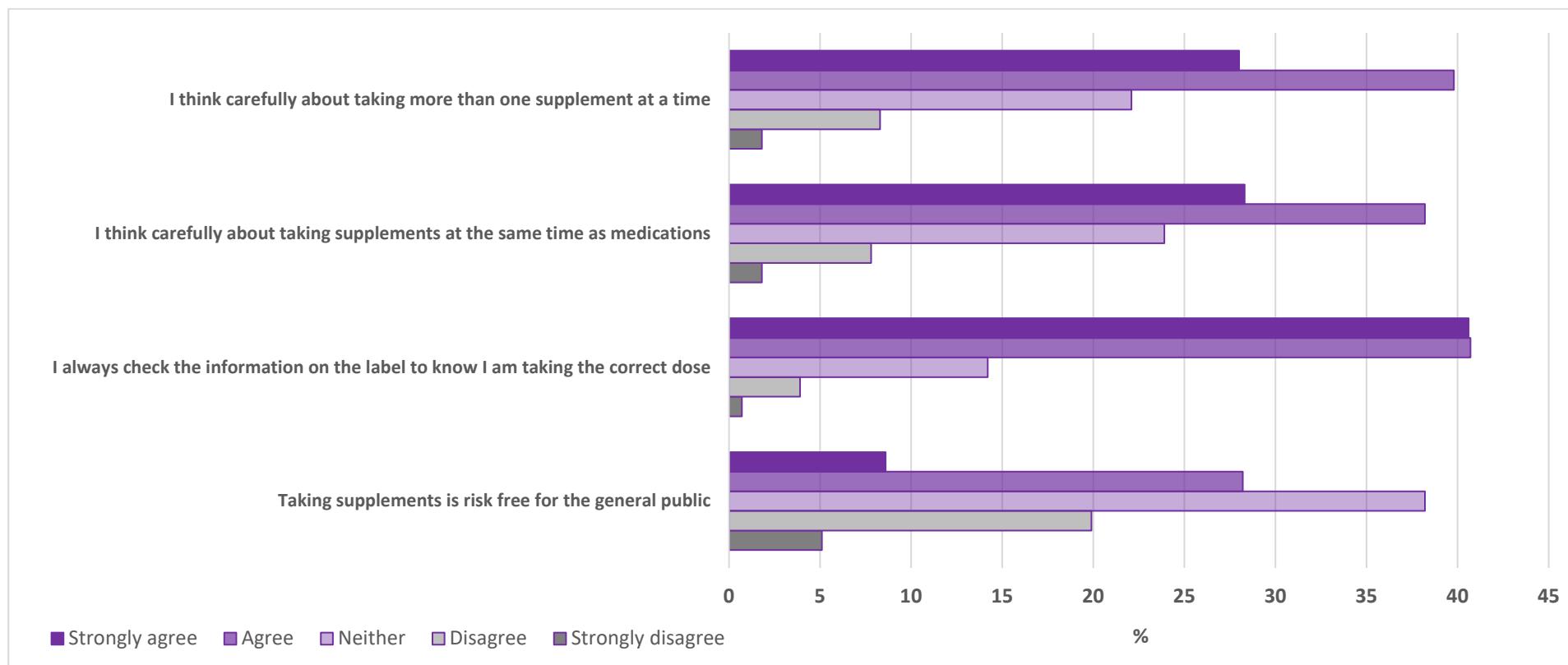


Figure 6 Responses to the 4 “awareness” items related to the risk or safety of food supplements use in a quantitative survey of 2,000 adults on the island of Ireland.



Theory of Planned Behaviour construct variables among food supplements users and non-users

Table 17 shows the mean scores and standard deviation from the mean for all Theory of Planned Behaviour predictor variables (intention, attitude, subjective norms, self-efficacy, controllability, perceived behavioural control, behavioural beliefs, normative beliefs and control beliefs) and knowledge of food supplements were significantly higher in food supplements users, compared with non-users.

Perceived health status and awareness of risk or safety around food supplements use were not significantly different between users and non-users.

Table 17 Theory of Planned Behaviour construct variables, assessed using 5-point Likert scales, among food supplements users and non-users in a quantitative survey of 2,000 adults on the island of Ireland

Theory of Planned Behaviour construct variable	Number of items	Score range	Total sample n = 2,000 Mean score; standard deviation	Users n = 956 Mean score; standard deviation	Non-users n = 1044 Mean score; standard deviation	P-value ^a
Intention	3	1 to 5	3.54; 1.32	4.41; 0.67	2.74; 1.27	Below 0.001
Attitude	4	1 to 5	3.79; 0.71	4.17; 0.54	3.44; 0.67	Below 0.001
Subjective norms	4	1 to 5	2.49; 1.05	2.75; 0.99	2.25; 1.05	Below 0.001
Self-efficacy	3	1 to 5	4.23; 0.76	4.52; 0.55	3.96; 0.82	Below 0.001
Controllability	3	1 to 5	4.12; 0.79	4.16; 0.75	4.08; 0.82	0.027
Perceived behavioural control	6	1 to 5	4.17; 0.66	4.34; 0.58	4.02; 0.69	Below 0.001
Behavioural beliefs ^b	8	-80 to +80	24.81; 17.04	30.05; 16.04	20.00; 16.52	Below 0.001
Normative beliefs ^b	7	-70 to +70	4.98; 15.46	10.70; 14.50	-0.25; 14.43	Below 0.001
Control beliefs ^b	9	-90 to +90	25.22; 20.82	32.17; 20.29	18.87; 19.20	Below 0.001
Health	1	1 to 4	3.01; 0.61	3.03; 0.61	2.99; 0.60	0.081
Knowledge	6	1 to 6	2.49; 1.09	2.64; 1.02	2.36; 1.14	Below 0.001
Awareness of risk or safety	4	-2 to +2	2.68; 2.42	2.76; 2.29	2.61; 2.53	0.160

^a Difference between groups. (Independent t-test used; P below 0.05).

^b The “indirect beliefs” Theory of Planned Behaviour construct score is calculated from [“behavioural beliefs” (1 to 5) multiplied by outcome evaluations (-2 to +2); “normative beliefs” (1 to 5) multiplied by motivation to comply (-2 to +2); and “control beliefs” (1 to 5) multiplied by power (-2 to +2)]. A positive score indicates that the participant is in favour of, experiences pressure to, and feels in control of taking supplements, respectively.

Associations between Theory of Planned Behaviour construct variables and intention to use food supplements

Controllability and perceived health status did not correlate (did not connect closely) with intention to take food supplements within the next month, whereas all other Theory of Planned Behaviour variables and “knowledge” and “awareness of risk or safety” scores correlated positively with intention (all P-values below 0.01).

Age was the only variable to negatively correlate with intention (P below 0.01) (Table 18).

Attitude emerged as having the strongest relationship with intention, followed by normative and control beliefs, behavioural beliefs, self-efficacy, subjective norms, perceived behavioural control and knowledge and awareness of risk or safety scores, respectively.

Table 18 Pearson's bivariate correlation coefficient (*r*) showing association between Theory of Planned Behaviour construct variables and intention to use food supplements, in a quantitative survey of 2,000 adults on the island of Ireland

	Attitude	Subjective norms	Self-efficacy	Controll-Ability	Perceived behavioural control	Behavioural beliefs	Normative beliefs	Control beliefs	Health	Knowledge	Risk or safety	Age
Intention	.687**	.462**	.478**	.018	.285**	.480**	.548**	.507**	.038	.159**	.090**	-.162**
Attitude		.263**	.535**	.180**	.415**	.605**	.442**	.552**	.055*	.158**	.086**	-.020
Subjective norms			.091**	-.349**	-.156**	.199**	.689**	.344**	.008	.068**	.013	.252**
Self-efficacy				.459**	.848**	.511**	.287**	.514**	.099**	.154**	.157**	.122**
Controllability					.860**	.227**	-.176**	.172**	.049*	.074**	.111**	.317**
Perceived behavioural control						.429**	.060**	.398**	.086**	.133**	.156**	.259**
Behavioural beliefs							.401**	.626**	.098**	.172**	.221**	-.026
Normative beliefs								.480**	.084**	.098**	.107**	.202**
Control beliefs									.118**	.179**	.200**	-.113**
Health										.034	.123**	.075**
Knowledge											.121**	-.050*
Awareness of risk or safety												.018
Age												

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Predictors of food supplements use behaviour and intention to use supplements

Table 19 shows results from hierarchical logistic regression analyses to predict food supplements use; essentially, proposing theoretical “models” made up of different combinations of the predictor variables to find out which is the most accurate.

At the first step, only *gender* and *socioeconomic status* were significant predictors of food supplements use, with 58.6 per cent of participants correctly classified by the predictive model as being “users” or “non-users” based on these sociodemographic factors.

At the second step, *knowledge* was the other significant predictor added without substantially changing the predictive power of the model (58.8 per cent). Neither perceived health status nor levels of awareness of risk or safety around food supplements use were significant at this step.

Intention was added separately at the third step, which was a significant predictor of food supplements use, increasing the proportion of participants correctly classified as users or non-users to 80.5 per cent. For every single unit increase in “intention” score, the odds of being a food supplements user were 5 times higher (OR 5.33). *Age* and *awareness of risk or safety* also became significant predictors from this step onwards, having a modest effect on behaviour (OR of approximately 1.02 and 0.92, respectively).

At the fourth step, *attitude* was another significant predictor added without substantially changing predictive power of the model (80.9 per cent). In this case, the odds of using food supplements roughly doubled for every single unit increase in attitude score. Subjective norms and perceived behavioural control were not predictive at this step, which remained the same in the final model.

The *indirect beliefs* scores were added into the fifth and final step. Only *behavioural beliefs* and *normative beliefs* were predictors of food supplements use, with 82.0 per cent of participants correctly classified as users or non-users based on the final model. The odds ratios for these “beliefs” variables were similar, albeit in opposite directions (0.98 and 1.02, respectively).

In the final model, the major determinants (predictors) of food supplements use were

- Being female
- Having higher socioeconomic status

- Having more positive pre-existing intentions or attitudes towards food supplements use (explaining 42.7 per cent of the variance)

Table 19 Predictors of food supplements use determined by hierarchical logistic regression analyses in a quantitative survey of 2,000 adults on the island Ireland

Step	Models	Odds ratio ^a	95 per cent confidence interval	P-value
Step 1 <i>(R² = 0.031)</i>	Gender	1.793	(1.492, 2.155)	Below 0.001
	Age	1.002	(0.997, 1.008)	0.423
	Socioeconomic status	0.639	(0.533, 0.766)	Below 0.001
Step 2 <i>(R² = 0.046)</i>	Gender	1.795	(1.488, 2.165)	Below 0.001
	Age	1.003	(0.998, 1.009)	0.241
	Socioeconomic status	0.659	(0.549, 0.792)	Below 0.001
	Perceived health status	1.094	(0.940, 1.272)	0.246
	Knowledge	1.263	(1.161, 1.374)	Below 0.001
	Awareness of risk or safety	0.995	(0.957, 1.033)	0.786
Step 3 <i>(R² = 0.412)</i>	Gender	1.455	(1.138, 1.861)	0.003
	Age	1.019	(1.012, 1.027)	Below 0.001
	Socioeconomic status	0.596	(0.468, 0.758)	Below 0.001
	Perceived health status	1.020	(0.834, 1.248)	0.844
	Knowledge	1.074	(0.960, 1.202)	0.215
	Awareness of risk or safety	0.917	(0.868, 0.969)	0.002
Step 4 <i>(R² = 0.421)</i>	Intention	5.330	(4.572, 6.212)	Below 0.001
	Gender	1.372	(1.067, 1.763)	0.014
	Age	1.018	(1.010, 1.026)	Below 0.001
	Socioeconomic status	0.587	0.750)	Below 0.001
	Perceived health status	1.003	(0.817, 1.231)	0.981
	Knowledge	1.067	(0.952, 1.196)	0.266
	Awareness of risk or safety	0.914	(0.864, 0.968)	0.002
	Intention	4.483	(3.729, 5.391)	Below 0.001
	Attitude	1.995	(1.545, 2.577)	Below 0.001
Step 5 <i>(R² = 0.427)</i>	Subjective norms	0.959	(0.838, 1.098)	0.546
	Perceived behavioural control	0.804	(0.633, 1.022)	0.074
	Gender	1.412	(1.096, 1.819)	0.008
	Age	1.018	(1.010, 1.026)	Below 0.001
	Socioeconomic status	0.613	(0.478, 0.784)	Below 0.001
Perceived health status				
Knowledge				
Awareness of risk or safety				

Intention	4.550	(3.757, 5.510)	Below 0.001
Attitude	2.311	(1.756, 3.041)	Below 0.001
Subjective norms	0.872	(0.732, 1.039)	0.125
Perceived behavioural control	0.945	(0.729, 1.226)	0.671
Behavioural beliefs	0.981	(0.970, 0.991)	Below 0.001
Normative beliefs	1.017	(1.004, 1.030)	0.011
Control beliefs	0.996	(0.988, 1.005)	0.380

^a Odds ratio given as the exponential of “B”

Notes:

“R²” stands for “Cox-Snell R-squared”.

Non-significant variables were retained in the models.

Data is from logistic regression analysis resulting in overall percentage correctly classified as food supplements “users” and “non-users” at step 1 of 58.6 per cent; at step 2, 58.8 per cent; at step 3, 80.5 per cent; at step 4, 80.9 per cent; and at step 5 the percentage correctly classified was 82.0%.

Predictors of intention to take food supplements, determined by hierarchical multiple regression analysis, are presented in Table 20.

All sociodemographic factors (*gender, age* and *socioeconomic status*) significantly predicted intentions at the first, third and fourth steps of the analysis.

At the second step, *knowledge* and *awareness of risk or safety scores* were significant additions to the model but with a modest effect on the change in the R² (from 5 per cent to 7 per cent).

There was a bigger significant change in the R² at the third step, with the direct Theory of Planned Behaviour construct variables (*attitudes, subjective norms* and *perceived behavioural control*) all positively predicting intentions to take food supplements and accounting for 58 per cent of the variance in the model.

The final model explained 59 per cent of the variance with *sociodemographic* variables, direct Theory of Planned Behaviour construct measures (*attitudes, subjective norms* and *perceived behavioural control*) and *normative beliefs* making unique contributions to the prediction of intention to take food supplements.

This indicates that intentions towards food supplements use increases among

- Females
- Younger adults

- Those with higher socioeconomic status
- Those with more favourable attitudes towards food supplements and their use, higher subjective norms and more perceived behavioural control (a person's belief in their ability to act or to change their environment)
- Those experiencing more social pressure towards undertaking the behaviour.

Perceived health status, knowledge, awareness of risk or safety around food supplements, behavioural beliefs and control beliefs did not predict intentions to use food supplements.

Table 20 Predictors of intentions to take food supplements, determined by hierarchical multiple regression analyses in a quantitative survey of 2,000 adults on the island of Ireland

Step	Predictor variables	Standardised beta, or β	Standard error, or SE	P-value
Step 1 ($R^2 = 0.050$; P below 0.001)	Gender	0.155	0.059	Below 0.001
	Age	-0.131	0.002	Below 0.001
	Socioeconomic status	-0.045	0.059	0.039
Step 2 ($R^2 = 0.073$; P below 0.001)	Gender	0.143	0.059	Below 0.001
	Age	-0.126	0.002	Below 0.001
	Socioeconomic status	-0.037	0.058	0.086
	Perceived health status	0.010	0.048	0.642
	Knowledge	0.139	0.026	Below 0.001
	Awareness of risk or safety	0.055	0.012	0.014
Step 3 ($R^2 = 0.579$; P below 0.001)	Gender	0.050	0.040	0.001
	Age	-0.097	0.001	Below 0.001
	Socioeconomic status	-0.030	0.039	0.041
	Perceived health status	-0.019	0.032	0.208
	Knowledge	0.027	0.018	0.069
	Awareness of risk or safety	0.014	0.008	0.350
	Attitude	0.536	0.032	Below 0.001
	Subjective norms	0.314	0.020	Below 0.001
	Perceived behavioural control	0.127	0.035	Below 0.001
Step 4 ($R^2 = 0.588$; P below 0.001)	Gender	0.055	0.040	Below 0.001
	Age	-0.085	0.001	Below 0.001
	Socioeconomic status	-0.030	0.039	0.043
	Perceived health status	-0.027	0.032	0.069
	Knowledge	0.026	0.018	0.083

Awareness of risk or safety	0	0.008	0.981
Attitude	0.486	0.037	Below 0.001
Subjective norms	0.224	0.027	Below 0.001
Perceived behavioural control	0.108	0.037	Below 0.001
Behavioural beliefs	0.015	0.002	0.459
Normative beliefs	0.133	0.002	Below 0.001
Control beliefs	0.027	0.001	0.190

Notes:

Standardised beta, or “ β ” means.

Standard error, or “SE”, means.

“R²” is the “adjusted R-squared.”

Data is from hierarchical linear regression analysis. Delta R-squared, or “ ΔR^2 ”, (F change): 0.051 (35.83), 0.024 (17.51), 0.505 (798.99), 0.009 (15.25) for steps 1 to 4, respectively.

From additional multiple regression analyses, Table 21 details the top 3 most influential factors under each Theory of Planned Behaviour construct contributing to adults’ intentions to use food supplements within the next month.

Table 21 Top 3 factors influencing intention to use food supplements within the next month for the 3 Theory of Planned Behaviour constructs that contribute most to intention, determined by multiple regression analyses in a quantitative survey of 2,000 adults on the island of Ireland

Theory of Planned Behaviour constructs that contribute most to intention to use food supplements	Top three factors ^a influencing intention to use food supplements
Behavioural beliefs (<i>attitudes</i>)	Positive influence: Benefit to health or prevention of ill-health Negative influence: Cost Positive influence: Support for the immune system
Normative beliefs (<i>subjective norms</i>)	Positive influence: Family Positive influence: Healthcare professionals Positive influence: Other people (for example food supplements users with a positive experience of using supplements) ^b Negative influence: The older generation (non-users) ^b
Control beliefs (<i>perceived behaviour control</i>)	Positive influence: Ability to buy Positive influence: Knowledge of being at a stage of life when food supplements are important for health Positive influence: Having food supplements readily available ^b Negative influence: Not remembering or not being in the habit to take food supplements ^b

Notes:

^a Perceived beliefs reported and assessed in Theory of Planned Behaviour framework. Contribution determined from the highest 3 partial correlations squared from linear regression models for each construct. Each predicted between 1 per cent and 12 per cent of the variance.

^b Joint-third in influencing the most contributing factors.

5 Discussion

This project reports that around half of adults on the island of Ireland are currently taking food supplements, and the most common pattern of use is taking 1 to 2 types of food supplements daily for the last 6 months. Consumers of food supplements are most likely to buy these food supplements from a chemist or pharmacy. The proportion of current supplement users observed in this research is higher than that reported previously in the UK or by national dietary surveys in UK and in Ireland (10-12), suggesting that food supplements use may be increasing among the general adult population.

As the quantitative survey was conducted in April 2021, it is reasonable to suggest that the ongoing COVID-19 pandemic may have influenced these findings. Indeed, “protection against COVID-19” was one of the main perceived advantages of food supplements that emerged from the qualitative themes and was explicitly mentioned by participants in addition to “generally supporting the immune system” (for example in preventing colds and flus).

The most frequently consumed food supplements reported by both current and past users in the current project were vitamin D and vitamin C, as well as multivitamins or multiminerals. This supports the idea that increased food supplements use is motivated by the perceived advantage of prevention of ill-health and generally supporting the immune system.

Research in this area is particularly timely, as the COVID-19 global pandemic has highlighted the importance of ensuring sufficient micronutrient status within at-risk groups in the population, (including older adults) (27). Indeed, a recent infodemiology study using Google® Trends® data has demonstrated an increase in searches for vitamins since the beginning of the COVID-19 pandemic⁵ (44) (35) . Follow-up research is needed, after the COVID-19 pandemic, to determine any changes over time in behaviours and patterns of food supplements use in the long term.

⁵ [Determination of interest in vitamin use during COVID-19 pandemic using Google Trends data: Infodemiology study - PubMed \(nih.gov\)](#)

Levels of knowledge and awareness of risks or safety associated with food supplements use were low in the current study, supporting previous research findings (35, 68, 87) and highlighting a need for updated, clear and consistent consumer messages in this area. Moreover, around 2 out of 5 adults believe that the use of food supplements is “risk-free” for the general public. Although this may not be of immediate concern based on the current patterns of use reported, with the growing interest and demand for food supplements it is important that consumers are making informed choices with regards to food supplements use, especially relating to product safety and effectiveness. This could be achieved through the provision of targeted, evidence-based public health initiatives.

Findings from the audit of a sample of the French Agency for Food, Environmental and Occupational Health and Safety’s nutrивigilance newsletters within the current project have provided an evidence-based insight into clinical cases of adverse events associated with the consumption of food supplements and other food products. These findings may inform the translation into practice of this scheme as a model for the identification, reporting and monitoring of suspected adverse events related to the use of such products in other countries – addressing, in part, one of the FSAI’s ongoing priority research areas (88). Subsequently, this may improve knowledge of food supplements use and consumer safety, thus informing public health recommendations in this area (which are currently limited).

The project has revealed the most important personal, social and psychological factors that influence food supplements use. Such data will be useful to inform and support the design and implementation of consumer education and future interventions (strategies and actions) relating to food supplements on the island of Ireland:

- *Intention* to take food supplements increases among females, younger adults, those with higher socioeconomic status, and those with more favourable pre-existing attitudes towards food supplements, with higher subjective norms, more perceived behavioural control and more social pressure towards undertaking the behaviour.
- Similarly, the major determinants of *behaviour* (that is, food supplements use) were being female, of a higher social class and having more positive intentions or attitudes towards supplements.
- Analyses identified that the most important social *positive influencers* towards food supplements use are healthcare professionals and family.

Identification of the “positive influencers” in relation to food supplements use may help to inform the design and imagery associated with future public health communications. Furthermore, it is important that such consumer advice also challenges the major disadvantages and barriers to food supplements use that were reported, such as the cost and not remembering to take them. For example, public health campaigns should give hints and tips to help consumers get into the habit of only taking food supplements that are needed, as well as supporting consumers in making lower-cost choices such as own-brand products and only taking supplements that are recommended.

The proportion of non-users of food supplements and the wide range of intentions towards the use of supplements reported in this group is noteworthy, despite the mainly positive attitudes wider range of facilitators towards food supplements use that emerged from the qualitative results. Given the importance of supplementation in achieving sufficient micronutrient intake in certain circumstances (for example with vitamin D over the winter months, or with folic acid for women of childbearing age), strategies to promote compliance with public health policy on food supplements may be considered to target non-users and those with generally lower intentions who are less likely to change their behaviour towards food supplements. Further research is required to explore consumer understanding and opinions of food supplements and fortified foods (foods with nutrients added to the ingredients) and biofortified foods (which are nutritionally enhanced food crops that are developed to be easily absorbed for use by the body) to inform such strategies.

Education (for example continuing professional development) for all healthcare professionals will help to ensure current public health messages are supported at the point of care. The findings of this project should be shared with regulatory bodies and other stakeholders, such as The Health and Food Supplements Information Service (HSIS) [Health & Food Supplements Information Service \(hsis.org\)](http://Health & Food Supplements Information Service (hsis.org)) in the design and implementation of such training or workshops. Given that adults on the island of Ireland are primarily buying their own food supplements and identified this convenience as a major facilitator for their use, updated guidance at common points-of-sale for food supplements (for example in pharmacies or on supermarket shelf-edges) may be a useful delivery route for future public health communications. Moreover, signposting to public health policy guidance and trusted sources of information for those looking for accurate and reliable information on food supplements is key.

Strengths and limitations

It is important to note that, while data are only observational and are likely to reflect circumstances at the time when the fieldwork was conducted, research methodologies were employed to ensure a robust sample size was achieved in a representative sample of adults from across the island of Ireland, to better inform future **safefood** communications resulting from this work.

The interdisciplinary project team employed a mixed study methods approach based on a validated theoretical framework (the Theory of Planned Behaviour) (14), to obtain a comprehensive understanding of food supplements use in adults on the island of Ireland. The Theory of Planned Behaviour enhances the understanding of health behaviours and underlying cognitive decision-making processes, to inform educational strategies aimed at changing attitudes and ultimately behaviour, which are more effective when guided by theory (15, 16, 21). Future research would be needed to determine the effectiveness and impact of such consumer education initiatives on food supplements use in the long term.

It was not feasible within the scope of the project to fully assess compliance to all current recommendations with regards to food supplements use and, although some insights have been presented, results should be interpreted with caution. The results are reliant on self-reported data which, despite the robust sample size, are dependent on each participant's ability to identify food supplements they may have been prescribed by a healthcare professional. For example, it is reasonable to suggest that some older adults might be prescribed a food supplement but may not necessarily recognise it as a food supplement rather than a medication, especially if prescribed under a branded name or if they are prescribed multiple items. This may partly explain the relatively low proportion of adults who reported getting their food supplements on prescription.

In the qualitative elicitation study the terms “vitamin(s)” or “multivitamin” were used interchangeably for “food supplements” by many participants in the focus groups, suggesting that adults did not recognise the broad definition of food supplements covered by the scope of this project.

While this research project will provide new and updated data that will be relevant to a wide range of nutrition scientists and stakeholders, specific Theory of Planned Behaviour studies should be repeated to allow a more in-depth exploration of food supplements use for specific

nutrients and subgroups of interest (such as older people, women of childbearing age and vegans and vegetarians). Such research would also be better placed to assess compliance with government policy and public health advice.

The project enabled the development of collaborative networks between academic and public health partners on the island.. The project has allowed the research team to further develop contacts with “Healthy Living Centres” in Northern Ireland and “Family Resource Centres” in Ireland, which will facilitate mutually beneficial work (research and its broadcast or communication, as well as other outreach activities) in the future. Such relationships are vital to the effective design, implementation and translation of public health research into practice across the island of Ireland.

The sample size for the quantitative research is robust and was achieved using a cost-effective approach, administering the omnibus surveys through a market research company. While data have largely been presented within the report on an all-island basis, the sample is sufficient to be representative of each jurisdiction separately, providing scope for data-sharing and additional secondary analysis relevant to Northern Ireland and Ireland specifically in the future as required. Working with Cognisense (market research company) has also helped to maintain existing relationships with regards to the conduct of market research and representative sampling, which will inform plans for future qualitative and quantitative research.

Conclusions

This research adds to the existing evidence base regarding food supplements and provides a new, representative dataset for the island of Ireland suggesting a general increasing trend in food supplements use, as well as providing key insights into the type of supplements, frequency and duration of use, context for use and purchasing behaviour in adults across the island of Ireland. The project work has revealed the most important personal, social and psychological factors that influence food supplements use and such data will be useful to inform and support the design and implementation of consumer education and future interventions (strategies and actions) on food supplements on the island of Ireland which are warranted based on the findings. The audit of nutrivigilance newsletters has strengthened the interpretation of findings and pointed to how adverse events associated with food supplements are recorded in France.

Future research

The project identified areas for future research in this increasingly important area for public health that should be explored to investigate

- The effectiveness and impact of consumer education on food supplements use.
- Specific Theory of Planned Behaviour studies repeated for supplementation of specific nutrients and subgroups of interest (such as older people, women of childbearing age and vegetarians and vegans) to assess compliance with government recommendations and public health advice.
- Follow-up data collection and studies after the COVID-19 pandemic to determine changes over time in behaviours and patterns of food supplements use in the long term.
- Consumer understanding and opinions of food supplements, fortified foods and biofortified foods.

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Appendix 1 Focus group discussion guide

Online focus group sessions were conducted to gather rich qualitative data to inform the design of the quantitative survey. These groups were primarily used to

- Gain a better understanding of participants' beliefs, attitudes and knowledge around food supplements use
- Deepen our understanding of the rationale behind the most common reasons adults choose to take food supplements (and barriers that discourage or prevent them from taking supplements)
- Determine the drivers for change behind such motivations and barriers.

Each focus group discussion included "open-ended" questions, in keeping with recommended Theory of Planned Behaviour protocols.

Introduction and rules

- Introduce researchers; explain research and thank participants for attending
- Objective: to collect thoughts and opinions; safe space; no right or wrong answers etc.
- All honest contributions are valid, and different opinions are also expected
- Avoid direct questions to us
- Try to speak one at a time so all views are captured
- Please use video so we can interact as best as possible
- Note about distractions (mobile phones, others in household etc.) – try to mute
- Session will be recorded but only for transcription purposes
- Written data will be anonymised

CHECK: Completion of demographic questionnaire and online consent form

Ice-breaker – name and where you are living

Key discussion topics

Allow discussion to flow as naturally as possible as some topics may be covered throughout the conversation.

- What is your **understanding** of food supplements?

- Explore current **behaviours** of the group regarding food supplements
 - **Intentions** – change behaviour in the next month?

Show **definition** ... Any opinions or thoughts?

- Theory of Planned Behaviour construct questions:

Attitude

1. What do you believe are the **advantages** of taking supplements?
2. What do you believe are the **disadvantages** of taking supplements?
3. Is there **anything else** you associate with your **own views** about taking supplement(s)?

Subjective norms (social influences)

4. Are there any individual or groups who would **approve** of you taking supplement(s)?
5. Are there any individual or groups who would **disapprove** of you taking supplement(s)?
6. Is there anything else you associate **with other people's views** about taking supplement(s)?

Perceived behavioural control (barriers/facilitators)

7. What factors or circumstances would **enable** you to take supplement(s)?
8. What factors or circumstances would make it **difficult or impossible** for you to take supplement(s)?
9. Are there any **other issues** that come to mind when you think about taking supplement(s)?

- Any other comments, views or opinions

Further probing questions or prompts; for example, Could you give me an example of that? Would you mind explaining that further? Can you talk about that more? etc.

Appendix 2: Survey questionnaire



Food supplements – Exploring our reasons for taking them

OMNIBUS QUESTIONNAIRE

Researcher notes (italics) – (Indicates filtering)

Questionnaire structure

PART	DESCRIPTION	Question numbers
1	Current behaviour (<i>some with filtering; some for all</i>)	1 to 10
2	Knowledge or awareness (<i>for all</i>)	11 and 12
3	Theory of Planned Behaviour constructs (<i>for all</i>) i. Intentions ii. Construct 1 – attitudes iii. Construct 2 – subjective norms iv. Construct 3 – perceived behavioural control	13 14 to 19 20 to 22 23 to 26
4	Other (<i>for all</i>)	27 and 28

Question types

- 11 closed responses (multiple options)
 - +3 with *if other, please specify* (open response)
- 1 “True / False / Don’t know” (6 items)
- 1 “Yes / No”
- 15 Likert scales (1 to 9 items each; total 69 items)

Respondents will answer between 20 and 28 questions (79 to 90 items), depending on filtering

Food supplements definition

To be shown to all at the beginning (can be bulleted/shortened if required)

“any foodstuff the purpose of which is to supplement the normal diet and which are concentrated sources of nutrients [vitamins/minerals] or other substances with a nutritional or physiological effect, alone or in combination, marketed in dose form, namely forms such as capsules, pastilles, tablets, pills and other similar forms, sachets of powder, ampoules of liquids, drop dispensing bottles, and other similar forms of liquids and powders designed to be taken in measured small unit quantities”.

... *or*:

- any foodstuff
- purpose is to supplement the normal diet
- concentrated sources of nutrients [vitamins/minerals] or other substances
- with a nutritional or physiological effect, alone or in combination
- marketed in dose form
- forms such as capsules, pastilles, tablets, pills and other similar forms, sachets of powder, ampoules of liquids, drop dispensing bottles, and other similar forms of liquids and powders
- designed to be taken in measured small unit quantities

PART 1 – Current behaviour

Q1: ALL

1. Which statement best describes your use of food supplements? (*Select one*)
 - a. I currently take a supplement (either regularly / irregularly) *directed to Q2-6*
 - b. I have taken supplements in the past 6 months but not currently *directed to Q7*
 - c. I have taken supplements in the past 12 months / 1 year but not currently *directed to Q7*
 - d. I have taken supplements in the past 2 to 5 years but not currently *directed to Q7*
 - e. I have taken supplements in the past but it was more than 5 years ago *directed to Q7*
 - f. I have never taken supplements *directed to Q8*

Q2-6: (If Q1a ticked) Current supplement users only

2. What supplement(s) do you currently take? (Tick all that apply)
 - (*responses randomised*) Multi- vitamin / mineral; Vitamin D; Vitamin C; Iron; Protein; B vitamin(s) / B complex; Vitamin B12 injection; Fish oils / Omega 3; Magnesium; Other sport / performance-related; Folic acid; Glucosamine sulphate; Electrolytes / rehydration; Other (Please specify)

3. Thinking of the main supplement(s) you currently take, how best describes how often you take them? (*Select one*)
 - Daily; 2-3 times per week; 4-5 times per week; Weekly; Fortnightly; Monthly; Less often
4. Thinking of the main supplement(s) you currently take, how best describes how long have you been taking them for? (*Select one*)
 - Last month; Last 6 months; Last year; Last 2 to 3 years; Longer than this
5. How are you most likely to get these supplements? (*Select one*)
 - a. On prescription (e.g. from GP/Doctor) *directed to Q8*
 - b. I buy these myself *directed to Q6*
 - c. Combination *directed to Q6*
6. (*If Q5a or b*) Where are you most likely to buy your supplement(s) from? (*Select one*)
 - (*responses randomised*) Chemist / Pharmacy; Health food shop; Supermarket; Local shop; Internet; Other (Please specify)

Q7: Past supplement users only (if Q1b-e ticked)

7. What supplement(s) have you taken in the past? (Tick all that apply)
 - (*responses randomised*) Multi- vitamin / mineral; Vitamin D; Vitamin C; Iron; Protein; B vitamin(s) / B complex; Vitamin B12 injection; Fish oils / Omega 3; Magnesium; Other sport / performance-related; Folic acid; Glucosamine sulphate; Electrolytes / rehydration; Other (Please specify)

Q8: ALL

8. Are you a parent / guardian / carer for anyone under 18 years old?
 - Yes *directed to Q9*
 - No *directed to Q11*
9. (*If Q8: Yes*) Which statement best describes your use of supplements for the child / children in your care?
 - a. My child / children currently take a supplement(s) (either regularly / irregularly) *directed to Q10a*
 - b. My child / children have taken supplements in the past but not currently *directed to Q10b*
 - c. My child / children have never taken supplements *directed to Q11*

10. What supplement(s) ... (*Same answer options for both*)

- a. (*If Q9a*) ... do you give to your child / children in your care?
- b. (*If Q9b*) ... have you given to your child / children in your care in the past?
 - (*responses randomised*) Multi- vitamin / mineral; Vitamin D; Vitamin C; Iron; Protein; B vitamin(s) / B complex; Vitamin B12 injection; Fish oils / Omega 3; Magnesium; Other sport / performance-related; Folic acid; Glucosamine sulphate; Electrolytes / rehydration; Other (Please specify)

PART 2 – Knowledge / Awareness

Q11-12: ALL

11. Can you please record whether you believe the following statements to be true or false (or don't know) (*Statements a-f randomised*)

- a. Supplements can only be sold in pill form (e.g. capsule or tablet)
- b. Supplements are considered as foodstuffs under EU law
- c. Taking supplements cannot prevent diseases in healthy people
- d. Before being marketed, supplements must be tested for efficacy and safety
- e. It is the seller's responsibility to ensure that supplements they are selling are safe for consumption
- f. The packaging of supplements must contain information on possible adverse effects resulting from their use

12. To what extent do you agree or disagree with the following statements?

Likert scale: Strongly disagree; Disagree; Neither; Agree; Strongly agree (Statements a-d randomised)

- a. Taking supplements is risk-free for the general public
- b. I always check the information on the label to know I am taking the correct dose
- c. I think carefully about taking supplements at the same time as medications
- d. I think carefully about taking more than one supplement at a time

PART 3 – Theory of Planned Behaviour constructs

Q13-26: ALL

(i) Intentions

Prompt: In this section of this questionnaire, we would like to explore your intentions towards supplement use within the next month. Please answer the following questions by selecting one response only.

13. Please indicate to what extent you agree / disagree with the following statements:

Likert scale: Strongly agree; Agree; Neither; Disagree; Strongly disagree

- a. I want to use a supplement within the next month
- b. I intend to use a supplement within the next month
- c. I am going to use a supplement within the next month

(ii) Attitude

Prompt: For Q14 to 17, please select the response that best describes your views towards using a supplement within the next month. In those highlighted, scales were reversed to read from positive-negative in scripted omnibus version.

14. Using a supplement within the next month would be:

Likert scale: Very harmful; Harmful; Neither; Beneficial; Very beneficial

15. Using a supplement within the next month would be:

Likert scale: Very healthy; Healthy; Neither; Unhealthy; Very unhealthy

16. Using a supplement within the next month would be:

Likert scale: Very good; Good; Neither; Bad; Very bad

17. Using a supplement within the next month would be:

Likert scale: Very foolish; Foolish; Neither; Wise; Very wise

Prompt: These questions are about some of the outcomes of using a supplement within the next month.

(Q18-19 - Statements from main advantages; disadvantages)

18. If you were to use a supplement within the next month, how likely or unlikely would you rate each of the following statements?

Likert scale: Very unlikely; Unlikely; Neither; Likely; Very likely

- a. Using a supplement within the next month would help to replace anything lacking in my diet
 - b. Using a supplement within the next month would benefit my health or prevent ill health
 - c. Using a supplement within the next month would benefit my joints
 - d. Using a supplement within the next month will have no effect on my health
 - e. Using a supplement within the next month would be costly for me
 - f. Using a supplement within the next month would support my immune system
 - g. Using a supplement within the next month would protect against COVID-19
 - h. Using a supplement within the next month would support me when exercising or playing sport
19. If you were to use a supplement within the next month, how good or bad would you rate each of these outcomes if they were to happen?
- Likert scale: Extremely good; Good; Neither; Bad; Extremely bad*
- a. Using a supplement within the next month to replace anything lacking in my diet would be:
 - b. Using a supplement within the next month to benefit my health or prevent ill health would be:
 - c. Using a supplement within the next month to benefit my joints would be:
 - d. Using a supplement within the next month to have no effect on my health would be:
 - e. Using a supplement within the next month, the cost for me would be:
 - f. Using a supplement within the next month to support my immune system would be:
 - g. Using a supplement within the next month to protect against COVID-19 would be:
 - h. Using a supplement within the next month to support me when exercising or playing sport would be:

(iii) Subjective norms

Prompt: Now we would like to know how you think other people expect you to act with regard to using a supplement within the next month.

(Q20-21 - Statements from main people / groups who approve; disapprove)

20. Please indicate to what extent you agree or disagree with the following statements:

Likert scale: Strongly agree; Agree; Neither; Disagree; Strongly disagree

- a. Health professionals think I should use a supplement within the next month
- b. My family think I should use a supplement within the next month

- c. Other supplement users think I should use a supplement within the next month
- d. Celebrities / influencers think I should use a supplement within the next month
- e. Other people would recommend that I use a supplement within the next month
- f. My friends think I should use a supplement within the next month
- g. The older generation think I should not use a supplement within the next month**

21. Please rate the following statements:

Likert scale: Not at all; A little; Neither; Mostly; Very much

- a. Doing what health professionals think I should do matters to me
- b. Doing what my family think I should do matters to me
- c. Doing what other supplement users think I should do matters to me
- d. Doing what celebrities / influences think I should do matters to me
- e. Doing what other people think I should do matters to me
- f. Doing what my friends think I should do matters to me
- g. Doing what the older generation think I should do matters to me**

22. Please indicate to what extent you agree / disagree with the following statements:

Likert scale: Strongly agree; Agree; Neither; Disagree; Strongly disagree

- a. I feel under social pressure to use a supplement within the next month
- b. People who are important to me think I should use a supplement within the next month
- c. People who are important to me want me to use a supplement within the next month
- d. It is expected of me to use a supplement within the next month

(iv) Perceived behavioural control

Prompt: Now we would like to ask you about factors that might encourage and / or prevent you from using a supplement within the next month.

(Q23-24 - Statements from main facilitators; barriers)

23. Please rate the following statements:

Likert scale: Very true; True; Neither; Untrue; Very untrue

- a. Being able to purchase a supplement would encourage me to use them
- b. Lack of knowledge would prevent me from using a supplement**
- c. The convenience of obtaining information online would encourage me to use a supplement

- d. Seeing them advertised would encourage me to use a supplement
 - e. Having supplements readily available would encourage me to use them
 - f. Knowing that I am at a stage in my life where supplements are important for health would encourage me to use them
 - g. Taking part in sports or exercising regularly would encourage me to use a supplement
 - h. Abnormal results from a health check or blood test would encourage me to use a supplement
 - i. Not remembering or not being in the habit of taking a supplement would prevent me from using them
- 24.** How easy or difficult would the following factors make it for you to use a supplement within the next month?
- Likert scale: Very difficult; Difficult; Neither; Easy; Very easy*
- a. Being able to purchase a supplement
 - b. Lack of knowledge about supplements
 - c. The convenience of obtaining information online
 - d. Seeing advertisement for supplements
 - e. Having supplements readily available
 - f. Knowing that I am at a stage in my life where supplements are important for health
 - g. Taking part in sports or exercising regularly
 - h. Abnormal results from a health check or blood test
 - i. Not remembering or not being in the habit of taking a supplement

Prompt: Now we would like to ask you how much personal control you feel you have when it comes to deciding if you will use a supplement within the next month.

- 25.** For me to use a supplement within the next month is:

Likert scale: Very easy; Easy; Neither; Difficult; Very difficult

- 26.** Please indicate to what extent you agree / disagree with the following statements:

Likert scale: Strongly agree; Agree; Neither; Disagree; Strongly disagree

- a. I am confident that I could use a supplement within the next month if I wanted to
- b. I am sure that I could use a supplement within the next month if I wanted to
- c. The decision to use a supplement within the next month is beyond my control
- d. Whether I use a supplement or not within the next month is entirely up to me

- e. It is mostly up to me whether I use a supplement or not within the next month

PART 4 – Other

Q27-28: ALL

27. How would you perceive your general health (Select one)

- Very healthy; Fairly healthy; Fairly unhealthy; Very unhealthy

28. Which of the following, if any, currently apply to you? (Select all that apply)

- (*responses randomised*) Diagnosed with a physical health condition; Diagnosed with a mental health condition; Pregnant; Breastfeeding; Vegetarian; Vegan, None of these

<<End/Submit>>

Appendix 3: Summary of scientific publications cited in a sample of the French Agency for Food, Environment and Occupational Health and Safety's nutrivigilance newsletters (number 59 August 2019 to number 71 August 2020)

Study author(s) (and year of publication)	Journal	Country	Study design	Study population	Number in sample, or "n"	Data collection method	Study aim	Result(s)/Conclusion(s)	Newsletter †
<u>Alomar and colleagues (2019)</u>	<i>Research Journal of Pharmacy and Technology</i>	United Arab Emirates (UAE)	Observational	Adults	318	Self-administered questionnaire	To assess knowledge of dietary supplement products, levels of consumption and occurrence of adverse events among UAE population.	The majority of respondents (51.3%) were DS users. Different adverse events of DS products were encountered by the participants. The prevalence of poor health status was significantly higher in respondents who ever used DS compared to those who did not use DS. This result demonstrates the urgent need to plan for awareness and educational program among public to improve their knowledge about the correct use of DS,	66

<u>Asali and colleagues (2020)</u>	<i>NFS Journal</i>	Jordan	Observational	Pregnant women	285	Interviewer-administered questionnaire	To investigate the different types of dietary supplements used during the pregnancy trimesters compared by sociodemographic factors.	especially in terms of indications and contraindications. Compliance with the intake of some nutrient supplements among pregnant Jordanian women living in the center of Jordan is acceptable as 96.8% used DS. However, more efforts are required to educate pregnant women and raise the awareness about the importance of supplement intake particularly in defiance cases in order to avoid maternal and fetal complications.	71
<u>Attipoe and colleagues (2018)</u>	<i>Military Medicine</i>	US	Cross-sectional, observational	Military personnel	1,706	Self-administered questionnaire	To determine the prevalence of use of energy drinks or energy shots in an active-duty military population and to elucidate common reasons for use, the most common side effects, and the perceived safety of these products	The prevalence of ED/ES use in the USA raises concerns regarding safety and appropriate use. Military Service members fit the targeted age and gender demographic of many marketing campaigns for ED/ES products, and many perceive these	62

Azizi and Tariq (2019)	<i>Journal of the College of Physicians and Surgeons Pakistan</i>	Pakistan	Cross-sectional, analytical study	Adolescents	308	Laboratory analysis	among self-reported users.	beverages as safe to use.
Bailey and colleagues (2019)	<i>JAMA Network Open</i>	US	Cross-sectional study	Pregnant females	1,003	Analysis of National Health and Nutrition Examination Survey (NHANES) data	To determine vitamin D deficiency (25-hydroxyvitamin D) (below 20 nanograms per millilitre) frequency among apparently healthy Afghan adolescents.	Hypovitaminosis D is prevalent among Afghan adolescents, more pronounced in girls. Wearing of traditional clothes, duration of sunlight, type of living and inadequate consumption of vitamin D rich foods are significant determinants of hypovitaminosis D.

<u>Bajraktari-Sylejmani and Weiss (2020)</u>	<i>European Journal of Drug Metabolism and Pharmacokinetics</i>	Germany	In vitro (in a test-tube or glass dish)	Human embryonic kidney cell line (HEK293)	3	Experimental	An investigation into whether the polymethoxyflavones nobiletin, sinensetin, and tangeretin and the flavonoid rutinosides didymin, hesperidin and narirutin can inhibit human organic anion transporting polypeptides (OATP) 1B1, 1B3, and 2B1, which are important transporters mediating drug–drug and food–drug interactions.	exceed dietary recommendations is warranted. All flavonoids investigated might contribute to the intestinal OATP2B1-based interactions with drugs observed with citrus juices or fruits. In contrast, the concentration of the polymethoxyflavones after consumption of citrus juices or fruits is most likely too low to reach relevant systemic concentrations and thus to inhibit hepatic OATP1B1 and OATP1B3, but there might be a risk when they are consumed as medicines or as DS.	71
<u>Baker and colleagues (2019)</u>	<i>Nutrients</i>	Australia	Observational	Army personnel	23,195	Self-administered questionnaire	To investigate the use of dietary supplements by active-duty Australian soldiers across a range of occupations, and to understand the associations between	This study reported that DS use in the Australian Army is more widespread than in the general Australian population, and a considerable proportion of DS users reported one or	62

<u>Ben-Sasson and colleagues (2020)</u>	<i>Complementary Therapies in Medicine</i>	Israel	Observational	Hospitalised patients	243	Interviews and questionnaire	supplement use and demographic and occupational characteristics, weight goals, and physical activity levels.	more adverse side effects and therefore, ongoing surveillance of DS use is important for tracking trends in use over time and gauging the effectiveness of strategies employed to alter patterns of DS use.
<u>Bukhari and colleagues (2020)</u>	<i>Aerospace Medicine and Human Performance</i>	US	Observational	Aviation personnel	188	Self-administered questionnaire and focus group	To evaluate the prevalence, disclosure and documentation of dietary supplements use among patients hospitalised in the internal medicine departments of an Israeli university hospital.	DS are commonly used by patients hospitalized. Many patients do not report such use to the physicians, and physicians do not document DHS use in patient medical files. This communication gap may have serious medico-legal ramifications due to DS side effects and DS interactions with other DS and with conventional drugs.

<u>Caraballo and colleagues (2020)</u>	<i>Nutrients</i>	Spain	Observational	Athletes	42	Self-administered questionnaire	To analyse the consumption of sports supplements in the different categories and groups of sailors based on the level of evidence, differentiating according to gender, competitive level and type of boat.	consider them generally safe, but would like to receive education about these beverages, other dietary issues, and Army policies governing their use in aircrew.	Those who competed internationally had a higher prevalence in the consumption of DS. SS intake was higher during competition days, regardless of sex or level of competition. Statistically significant differences were observed in sex, level of competition, and the type of boat.	68
<u>Cicero and colleagues (2020)</u>	<i>European Journal of Integrative Medicine</i>	Italy	Meta-analysis	Healthy subjects	8,535	A large meta-analysis of 53 randomised control trials	Investigate the risk of liver damage by the use of red yeast rice extract.		Drug induced liver injury associated with RYR intake are exceptional and hardly associated to RYR per se rather than to low-quality products. RYR use should be used with caution by patients with known liver disease.	71

<u>Corzo and colleagues (2020)</u>	<i>Nutrients</i>	Spain	Review	Previous publications	Not applicable / available	Literature searching	To review the role of selected marine and vegetal nutraceuticals in nutrition, health and disease.	Nutrivigilance and stricter manufacturing regulations are recommended. The use of each person's genetic profile for the prescription of nutraceuticals is a major goal to be striven for in order to improve their effectiveness in the prevention and natural treatment of prevalent diseases.	67
<u>Costa and colleagues (2019)</u>	<i>Free Radical Research</i>	Portugal	Review	PubMed® online database and European Food Safety Authority (EFSA) scientific opinions	Not applicable / available	Systematic literature searching	To review and discuss the occurrence of contaminants in marketed samples of food supplements in the last 2 decades, considering both scientific literature and notifications registered on the Rapid Alert System for Food and Feed (RASFF) portal.	The evaluation of the risk associated to the consumption of FS, especially in the elderly population, is challenging. Therefore, improved quality control procedures and monitoring programs should be pursued in order to avoid undesirable products and assure the safety of FS.	62
<u>Crenn (2020)</u>	<i>Nutrition Clinique et Métabolisme</i>	France	Review	Previous publications and	Not applicable / available	Literature searching	A review article on the benefits and risks of dietary supplements	It is important that consumers and patients: (a) be informed of the	69

	(ABSTRACT ONLY IN ENGLISH)							
<u>Ćwielag- Drabek and colleagues (2020)</u>	<i>Food Science and Nutrition</i>	Poland	Laboratory analysis	Dietary supplements analysed	41	Laboratory analysis	To investigate the heavy metal contents of dietary supplements manufactured from medicinal plants and assess the potential daily burden on their consumers.	importance of supply via a well-authenticated circuit; (b) warn healthcare professionals of the consumption of these products, in particular in the event of effects appearing potentially related. Specific and fragile populations (as elderly people, chronic pathologies, pregnant women, and children) must also be warned. DS show contamination with heavy metals; 68.3% of samples were contaminated with Cd and Pb and 29.3% were contaminated with Hg. The concentration of heavy metals depends on the country of production. The health risk associated with the intake of DS primarily depends on the duration of consumption. Pharmaceutical

<u>de Guingand and colleagues (2020)</u>	<i>Midwifery</i>	Australia	Observational	Pregnant females (n = 42) and partners (n = 23)	65	Questionnaire and focus groups	To explore pregnant women's and healthcare professionals' general knowledge, behaviours and attitudes toward nutritional supplements, and their thoughts on introducing creatine as a pregnancy supplement.	companies should include information on duration of consumption, determined from risk assessment analysis.	There is high acceptance of current recommended nutritional supplements in pregnancy. Implementing creatine as a new supplement will require substantive empirical evidence and changes to clinical guidelines. Public awareness and education would also be essential to consumer acceptability of creatine.	64; 67
<u>de Paula and colleagues (2020)</u>	<i>BMC Geriatrics</i>	Brazil	Case report	64-year-old female	1	Medical notes	To highlight the risk of self-medication, and how increasing consumption with no professional indication or supervision can pose a serious health risk to the population.	This case report shows that the self-administration of DS can become a risky behavior. DS are supposed to bring patient empowerment and reduce government spending in healthcare, but indeed		71

<u>Farkouh and Baumgärtel (2019)</u>	<i>International Journal of General Medicine</i>	Austria	Review	PubMed Central®, Medline® and Austria Codex® online databases	Not applicabl e / available	Systematic literature searching	A review on the safety and efficacy of red yeast rice, which is used to lower cholesterol levels.	represent a significant public health concern due to possible overdose and drug interactions. Red yeast rice products should only be made available with appropriate warnings as they have the same clinically relevant risk potential as statins. In 1 analysed DS, the presence of Pb and Mn in high concentrations was detected. In 2 ds, chromium concentrations were above the reference daily dose. This study also revealed discrepancies between label doses and the detected values, which discloses the deficiency in quality assessment and the unreliability of the labelling of these products. Indicating the need for a deeper
<u>Figueiredo and colleagues (2020)</u>	<i>Nutrients</i>	Portugal	Laboratory analysis	Dietary supplements analysed	25	Laboratory analysis	To carry out a risk assessment of trace elements and the mixture of elements present in food supplements for weight loss.	59 68

<u>Fontana and colleagues (2019)</u>	<i>Clinical Liver Disease</i>	US	Case control	31-year-old female	1	Medical notes	A report on the presenting features and outcomes of severe acute hepatitis attributed to a commonly used multi- ingredient supplement, OxyELITE Pro® (USP Labs®).	surveillance of food supplements. Clinicians should have heightened awareness of the risk of liver injury associated with the many DS products. Reporting of adverse events to the FDA, the product manufacturer, and local health authorities should be encouraged. In light of these findings, further regulations regarding the manufacturing, safety and efficacy testing, and monitoring of DS products available in the marketplace are advisable and recommended.	62
<u>Fox and colleagues (2020)</u>	<i>JGH Open</i>	New Zealand	Case report	27-year-old female	1	Medical notes	A report on hepatic toxicity secondary to hypervitaminosis A.	This case reports demonstrates the risk of hypervitaminosis A and the possi-ble need for restrictions on sales of unprescribed vitamin A. It is important that those prescribing	68

<u>Galnares-Olalde and colleagues (2019)</u>	<i>American Journal of Neuroradiology</i>	Mexico	Case report	41-, 30- and 37-year-old females	3	Medical notes	To present a review on the presentation of cytotoxic lesions of the corpus callosum caused by thermogenic dietary supplements.	vitamin A-containing medications are aware of these risks and monitor patients according to prescribing recommendations.	Thermogenics are potentially harmful DS that are widely as they can still be easily purchased online. These herbal preparations being labeled as natural does not mean that they are entirely safe. When used without medical supervision, they can produce toxic neurologic side effects.	61
<u>Gardana and colleagues (2020)</u>	<i>Helijon</i>	Italy	Laboratory analysis	17 cranberry extracts and 10 cranberry-based food supplements analysed	27	Laboratory analysis	To find markers to authenticate extracts or cranberry-based food supplements.	Analisis showed that four extracts and six DS were not compliant. Therefore highlighting the need for producers to standardize their extracts with chromatographic techniques to make sure that the product contains cranberry.	68	

<u>Gavrilova and colleagues (2020)</u>	<i>International Journal of Pharmaceutical Research</i>	Not applicable / available	Review	Not applicable / available	Not applicable / available	Not applicable / available	This paper presents an overview of technologies and methods of production of various assortments of protein-carbohydrate products, biologically active substances and food products of functional purpose, intended primarily for sports nutrition, which increases the functional reserves of the body, resistance to stress, promoting rapid recovery after physical activity.	NA (full-text not accessible)	68
<u>Güemes Heras and colleagues (2019)</u>	<i>Journal of Nutrition and Metabolism</i>	Spain	Observationa l	Paediatrician s	433	Self- administered questionnair e	An investigation into the dietary supplements practices among Spanish paediatricians in routine clinical conditions.	The use of DS to improve different conditions, is a widespread clinical practice among Spanish paediatricians. Administration regimens followed clinical guideline recommendations. There was a high level of satisfaction regarding	60; 62

<u>Hatami and colleagues (2020)</u>	<i>Gastroenterology and Hepatology from Bed to Bench</i>	Iran	Case report	35-year-old female	1	Medical notes	An investigation into glutamine powder-induced hepatotoxicity.	improvement of symptoms associated with the use of DS. Liver damage is a possible side effect of glutamine therefore it is necessary to consider hepatotoxicity as an adverse reaction in case of glutamine DS consumption. Health care professionals especially physicians and pharmacists, as prescribers and dispensers of these products, must know that consumption of these products may be associated with serious side effects.	68
<u>Homer and Mukherjee (2019)</u>	<i>Journal of Consumer Behaviour</i>	US	Observational	University students	251	Interview	To investigate consumers' lack of awareness and concern of potential adverse reactions, interactions, and inappropriate usage associated with dietary supplements.	This study highlights that consumers perceive that multi-ingredient supplements possess more severe adverse side effects compared with single-ingredient supplements. The data confirm that lay theories impact DS decision making and that the observed	60

<u>Hwang and Song (2020)</u>	<i>Mechanisms and safety assessment</i>	Korea	Review	Previous publications	Not applicable / available	Collective literature search	To investigate adverse effects of nicotinamides and to provide understanding of their underlying mechanisms and assessment of the raised safety concerns.	effects are consistent with an accessibility-diagnosticity framework. This review assures safety in current usage level of NAM, but also finds potential risks for epigenetic alterations associated with chronic use of NAM at high doses. It also suggests directions of the future studies to ensure safer application of NAM.
<u>Ibraheem and Mohammad (2019)</u>	<i>Indian Journal of Public Health Research and Development</i>	Iraq	Observational	University students	300	Self-administered questionnaire	An investigation into the attitudes and consumption habits of energy drinks among university students.	Energy drinks awareness and its effects is poor. A considerable percentage of students drink the energy beverages and the most common reasons were to increase concentration and improve wakefulness. The students that do not drink these beverages report that they do not due to fear of being addicted to them.

<u>Ikuta and colleagues (2019)</u>	<i>Journal of the Pharmaceutical Society of Japan (ABSTRACT ONLY IN ENGLISH)</i>	Japan	Observational	Consumers	Not applicable / available	Not applicable / available	An investigation into consumer awareness of the interaction between health foods and supplements with medicines.	Consumers knowledge is still limited and most of them do not consult with specialized physicians. Increased efforts to expand consumers understanding of the risk of interaction between supplements and medicines is necessary suggesting that a ``Database for guiding the interaction between medicines and health foods" could be a useful tool for providing this type of information.	63
<u>Jimenez and colleagues (2019)</u>	<i>JAAD Case Reports</i>	Utah	Case control	46-year-old female	1	Medical notes	An investigation into a case of a patient with dermatitis herpetiformis that was poorly controlled with a gluten-free diet and dapsone until her use of a kelp-containing dietary supplement was discovered to be the causative factor.	This report encourages patients with dermatitis herpetiformis that is refractory to continue standard treatment and their physicians to explore possible sources of iodide exposure in their daily diet or environment, especially in an easily overlooked	62

<u>Jurčić and colleagues (2019)</u>	<i>Acta Clin Croatia</i>	Croatia	Case report	54-year-old female	1	Medical notes	A report on liver damage that was suspected to originate from Herbalife® (Herbalife® Nutrition Ltd) product consumption.	component of the complete medical history—DS use. A connection between the use of Herbalife® products and liver damage was observed. The exact mechanism was not determined. Following removal of Herbalife® products, liver damage was resolved. Overall, more strict regulations of their production process and sale are necessary.	71
<u>Kiss and colleagues (2020)</u>	<i>Journal of Food and Nutrition Research</i>	Hungary	Observational	Recreational athletes	617	Survey	An investigation into the socioeconomic forces behind dietary supplements use.	61% of recreational athletes use at least one type of DS. There were no significant socio-economic differences. Athletes engaging actively in recreational sports consider DS consumption as a precondition of an improvement in performance.	71
<u>Kowalska and colleagues (2019)</u>	<i>Trends in Food Science and Technology</i>	Poland	Review	Various food regulatory data and reports,	Not applicable / available	Review of secondary data	To identify the main factors influencing food supplements noncompliance in	Polish consumers' health and economic interests are not being protected as	62

Lehmann
and
colleagues
(2019)

*Forensic Science
International*

Germany
Case report

34-year-old
male

1

Medical
notes

including the
Rapid Alert
System for
Food and
Feed (RASFF)
portal

the EU but with
specific emphasis
on Poland.

Polish national data
on food supplement
fraud and European
data show
irregularities related
to mislabelling, and
especially innate
characteristics in
terms of final
product's
composition and
attributed
characteristics
related to
nutrition/health
claims.

In consideration of all aspects of this case, it can be assumed that the long-term consumption of anabolic androgen steroids (AAS) caused apparently pathological changes of the heart. Over and above, the combination of anatomical (small lumen coronary artery, ventricular hypertrophy) and substance-induced risk factors led to the fatal cardiovascular failure.

<u>Lehmkuhle and colleagues (2020)</u>	<i>Food and Chemical Toxicology</i>	US	Laboratory analysis	Over-the- counter medicines and dietary supplements marketed for children and pregnant women in the USA	276	Laboratory analysis	To investigate food, drugs and cosmetics colourings Red No. 40, Yellow No. 5, Yellow No. 6, Blue No. 1, and Blue No. 2 levels in prenatal vitamin tablets, children's chewable and gummy vitamins, pain reliever tablets and syrups, and cough / cold / allergy tablets and syrups.	These data indicate that in general vitamins are not a significant source of FDC dyes when taken as directed. Pain reliever tablets and cough/cold/allergy tablets are also not significant sources of FDC dyes. However, pain reliever syrups and cough/cold/allergy syrups can be a significant contributor of Red No. 40 when taken episodically, sub- chronically, or chronically and levels can be significantly above the US FDA ADI in children. It is still unclear the extent that FDC dyes influence behavior in children. However, understanding the amount of FDC dyes present in OTC given to children when they are ill or suffering from chronic conditions such as allergies is important	71
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<u>Lombardi and colleagues (2020)</u>	<i>British Journal of Clinical Pharmacology</i>	Italy	Systematic review	Previous publications	23	MEDLINE® and Embase® online databases	An investigation into acute liver injury following use of turmeric dietary supplements in Tuscany. This SR confirmed the association between Curcuma longa and liver injury.
<u>Maiello and colleagues (2019)</u>	<i>Journal of Psychopathology</i>	Italy	Case report	38-year-old male	1	Medical notes	A description of a case of suspected intoxication due to a reckless use of a number of dietary supplements and herbal medicines (40 different compounds). This report supports the development of an active vigilance strategy and the development of specific education tools about the potential interactions of such compounds. The development of integrative medicine centers promoting interdisciplinary collaboration between patients and physicians etc.

<u>Malaguti and colleagues (2019)</u>	<i>Journal of Human Sport and Exercise</i>	Italy	Observational	European referees	71	Self-administered questionnaire	To investigate soccer field referees' and assistant referees' knowledge and consumption of dietary supplements.	Referees frequently consume DS especially those refereeing in lower categories. Referees often follow a friend's suggestion when instead of trusting a professional prescription. This study highlighted that National and international soccer federations should care more about their referee nutritional education.	64
<u>Mazzanti and colleagues (2019)</u>	<i>European Journal of Clinical Pharmacology</i>	Italy	Review	Suspected adverse reaction received by the Italian Phytovigilance system	66	Analysis of data from the Italian Phytovigilance system	To describe the safety profile of dietary supplements for weight control by analysing spontaneous reports of suspected adverse reactions received by the Italian Phytovigilance System (July 2010 to October 2017).	AR involved cardiovascular system (26%), liver (14%), central nervous system (12%), skin (9%), gastrointestinal system (17%), thyroid (8%), kidney (4%), and other organs/systems (10%). In 64% of cases, the reaction was serious. Dechallenge was positive in 46 cases; three cases of positive rechallenge	60

<u>Medin and colleagues (2020)</u>	<i>Journal of Trace Elements in Medicine and Biology</i>	Norway	Observational	Children and adolescents	1722	Online dietary questionnaire	were reported. After the causality assessment, the association between the product intake and the adverse reaction was judged as possible in the majority of the cases ($n = 43$; 65%). The data collected confirmed the existence of safety concerns on herbal dietary supplements used for body weight control, mainly related to quality of products and their use as self-medication. In this scenario, spontaneous reports represent the only tools available to monitor safety of these products.	63

<u>Messina and colleagues (2020)</u>	<i>Journal of Human Sport and Exercise</i>	Italy	Case report	Professional athletes	29	Interviewer- administered questionnaire	To investigate the amount of assumption and the satisfaction level of some nutritional supplements used by professional soccer players.	in the diet of this population.	Those with a limited intake of the main dietary contributors to iodine intake may be at risk, and adolescent girls seem to be especially vulnerable.	This survey revealed a great inter-individual variability on the intake of DS. All respondents (n = 29) said they take cholecalciferol (vitamin D3), 17 out of 29 creatine, 14 out of 29 whey protein, and 10 out of 29 dietary nitrates.	70
<u>Morgovan and colleagues (2019)</u>	<i>Farmacia</i>	Romania	Review	Analysis of government regulations relating to food supplements	Not applicabl e / available	Comparative and method interpretatio n	A review of current legislation in place in Romania relating to the food supplement market and identifying ways to improve consumer safety.		This study highlights the necessity to introduce the nutrivigilance as a habitual practice and activity of all authorities and actors from the Romanian DS' market, due the increase of DS consumption and their risks for the people's health.	59; 62	

<u>Mortazavi and colleagues (2020)</u>	<i>Oral Health and Preventive Dentistry</i>	Iran	Systematic review	Online databases and handsearching	34	Systematic literature searching	To identify medications that can cause halitosis.	Pharmaceutical therapy is a potential source of extra-oral halitosis. This finding can help clinicians detect the probable causes of halitosis. Further studies are needed to definitely determine the role of various medications in causing extra-oral halitosis.	70
<u>Păduraru and colleagues (2019)</u>	<i>Farmacia</i>	Romania	Observational	Patients	372	Questionnaire	To assess the factors that make the patient use nutritional supplements, the main categories of nutritional supplements, the patient's knowledge about the legislative regulations on food supplements and the patient's trust in the efficacy and safety of these products.	The use of nutritional supplements faces many problems such as the abuse of these products without the recommendation of a health specialist (physician or pharmacist), the possibility of online purchase from unsafe sources, the lack of information regarding the indications of the FS, efficacy and safety of these products, the poorly known legislative regulations of FS. This paper can conclude that the beliefs of the	65

Peña-Acevedo and colleagues (2020)

Clinical Toxicology

Colombia

Case report

Adults

36

Medical notes

A description of cases of severe bleeding disorders that presented in humans following consumption of a counterfeit multivitamin product.

evaluated people regarding nutritional supplements are rarely based on medical evidence and that the professional figures, like physicians and pharmacists should be more involved in this subject in order to avoid the abuse of supplements and interactions and potential adverse reactions of this products. Moreover, the authority regulations on this subject should be more complete to demonstrate the safety and efficacy of these products.

This cases series emphasize the importance of the Poison Control Center to detect promptly potential new exposure of hazards to hundreds of products to the population, some of them fraudulent.

66

<u>Peterslund and colleagues (2019)</u>	<i>Ugeskrift Laeger</i> (ABSTRACT ONLY IN ENGLISH)	Denmark	Case report	65-year-old male	1	Medical notes	This is a case report of a 65-year-old healthy male who had a daily intake of 315 milligrams of red yeast rice and was admitted to hospital with acute renal deficiency, hepatitis and rhabdomyolysis.	This case report underlines the potential problems with these remedies, namely a lack of knowledge of adverse effects and a lack of control with the production.	62
<u>Pinto and colleagues (2020)</u>	<i>Journal of Food Composition and Analysis</i>	Portugal	Laboratory analysis	Dietary supplements analysed	49	Laboratory analysis	To determine a wide panel of elements (26), both essential and non-essential / toxic, in several whey protein supplements available at local sports shops and websites.	The daily consumption of 50g of WP supplement does not contribute for more than 12.1 % (Cd) of those limits, as regards As, Cd, Pb and Hg. Thus, WP supplements can be considered safe products, regarding the presence of potentially toxic elements.	67
<u>Rahesh and colleagues (2019)</u>	<i>Baylor University Medical Center Proceedings</i>	US	Case report	54-year-old female	1	Medical notes	To present a review on the growing risk of vitamin D toxicity from inappropriate practice.	Vitamin D deficiency is highly prevalent and there are an increasing number of reports of vitamin D toxicity, mostly related to the misuse of over-the-counter supplements which would suggest that there is increased	62

<u>Richards and colleagues (2020)</u>	<i>American Journal of Emergency Medicine</i>	US	Case report	32-year-old male	1	Medical notes	To describe the development of life-threatening encephalopathy, hepatic failure, rhabdomyolysis and copper toxicity from the use of myriad bodybuilding supplements.	need for regulation by the FDA to prevent incidental toxicity, as seen in this case. DS and the constituents of these supplements and their metabolites may be harmful and not listed on the product label. Emergency physicians should therefore be aware of these potential deleterious effects and inquire about supplement use for cases of unexplained multiorgan toxicity.	70
<u>Ruperti- Repilado and colleagues (2019)</u>	<i>Frontiers in Medicine</i>	Switzerland	Case report	51-year-old male	1	Medical notes	To present a review on the first case of severe acute cholestatic hepatitis due to the intake of <i>Artemisia annua</i> tea as chemoprophylaxis for malaria.	This case presents a case of HDS induced cholestatic liver injury. Efforts should be undertaken to discourage the use of artemisinin-derivatives for malaria prevention. The case also highlights that there remains an inadequate understanding of the pathophysiology and	62

<u>Santos and colleagues (2019)</u>	<i>Clinical Practice and Epidemiology in Mental Health</i>	Brazil	Observational, case control	Patients with panic disorder (n = 65); Control group (n = 66)	131	Questionnaire	To assess caffeine use in patients with panic disorder and to ascertain if caffeine consumption is associated with sociodemographic or clinical features.	susceptibility to HDS induced liver injury. High caffeine consumption in PD patients could be explained by the development of tolerance with regular use of this substance. Subtypes of sensitive and non-sensitive PD patients could also explain why some of these patients are able to tolerate high doses of caffeine.	63
<u>Santos and colleagues (2020)</u>	<i>Phytotherapy Research</i>	Brazil	Systematic Review	Previous publications	23	PubMed®, Web of Science®, Scopus® were used to search literature	To review published case reports and case series from Los Angeles from 1976 to 2020 to describe the clinical features of herbal dietary supplements related to hepatotoxicity in this region.	This study highlights the challenge in causality assessment when multi-ingredients HDS are taken and the need for consistent publication practice when reporting hepatotoxicity cases due to HDS, to foster HDS liver safety particularly in Los Angeles.	70
<u>Savino and colleagues (2019)</u>	<i>Annali Di Igiene: Medicina Preventiva e Di Comunita</i>	Spain	Review	Previous publications	Not applicable / available	Literature searching	To investigate the use and abuse of drugs to support athletic performance and	The use of supplements, drugs and doping substances represents a complex	62

<u>Serdarevic and colleagues (2019)</u>	<i>Medical archives</i>	Sarajevo, Bosnia and Herzegovin a	Observationa l	University Students	960	Face-to-face interview and self- administered questionnair e	An investigation into the associations between vitamin B, folic acid, multivitamin or multimineral intake among the student population and the correlation with smoking prevalence and drinking coffee.	provide a tool to develop critical awareness of these problems. issue. Better education and a deeper knowledge of the issues of drugs, DSsnd doping are need to arouse an athletic awareness. More univocal regulation is required to create a more pragmatic approach and support control authorities. Study participants did not follow recommendations for FA and vitamin B supplements. More than half of students took multivitamins and minerals for less than one year. In both groups, smokers and not smokers, nine out of ten students did not take FA. The FA, multivitamins or mineral intake did not depend on smoking status. Drinking coffee and FA intake are mutually dependent, but B vitamins intake	61
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<u>Shafi and colleagues (2020)</u>	<i>Meta Gene</i>	Iraq	In vitro	Male adults	100	Experimental	To determine the effects of exercise and abuse of synthetic anabolic steroids and food supplements on micronuclei frequency in buccal cells and 8-hydroxy-2-deoxyguanosine (8-OHdG) as markers for deoxyribonucleic acid (DNA) damage.	did not depend on drinking coffee. Results outlined that exceeded usage DS exerted no increasing effects of oxidative DNA and/or chromosomal aberration accounting for serum 8-OHdG and micronuclei in buccal cells. These are possibly due to the adaptive responses such as up regulation of DNA repair systems and enhancement of the anti-oxidant capacity in highly-trained individuals.	68
<u>Shehadeh and colleagues (2020)</u>	<i>Eastern Mediterranean Health Journal</i>	Jordan	Observational	Females	858	Interviewer-administered questionnaire	An investigation into the use of complementary alternative medicines for weight management among adult females in Jordan and the possible relationship between use and body mass index.	This study revealed that CAM is often used for weight management. Awareness of the safe use of complementary and alternative medicine with other medications and during pregnancy and lactation should be addressed.	68

<u>Siddique and colleagues (2020)</u>	<i>World Journal of Hepatology</i>	US	Review	Patients with unexplained rise in liver enzymes	600	Retrospective review of clinically proven cases (2013 to 2017)	An investigation into the clinical-pathological findings of hepatic liver injury caused by drugs or herbal dietary supplements.	This report highlights outlines clinical findings of hepatic injury caused by drugs/HDS and with new products constantly being developed it is important to continue to report cases.	71
<u>Stefanescu and colleagues (2020)</u>	<i>Revista de Chimie</i>	Romania	Laboratory analysis	<i>Tribulus terrestris</i> products	2	Laboratory analysis	To investigate herbal drugs and food supplements frequently consumed on the market comprising of <i>Tribulus terrestris</i> and evaluate benefit / risk balance.	Both <i>tribulus terrestris</i> products exhibited strong antioxidant activity in vitro, but only the extract from the capsules had an antibacterial effect. This study raises awareness about the importance of accurate control of these supplements with an emphasis on the possible risks assumed by inadvertent consumption.	69
<u>Stohs and Ray (2020)</u>	<i>Journal of Dietary Supplements</i>	US	Systematic review and appraisal	Published case reports that involved <i>p</i> -synephrine, bitter orange and <i>Citrus aurantium</i>	33	Literature searching (Google® Scholar® and PubMed®)	To summarise all known case reports that have been published regarding adverse events associated with multi-ingredient	No case study reviewed the existing published literature, and all failed to note that numerous clinical studies have not demonstrated	69

				dietary supplements containing bitter orange extract.	adverse effects at commonly used doses. Most studies did not indicate the composition of the product involved, and no study analyzed the product in question. In no case was a direct correlation between the event and <i>p</i> -synephrine made. Although <i>p</i> -synephrine and ephedrine have some structural similarity, the structural differences result in markedly different pharmacokinetic, physiological, and pharmacological effects, and thus the effects produced by ephedrine cannot be extrapolated to <i>p</i> -synephrine.				
<u>Thalukder and colleagues (2019)</u>	<i>Dental Update</i>	UK	Review	Sports supplement available in the UK	Not applicable / available	Review and product audit	This paper focusses on identifying current evidence relating to caries risk and sports supplements, and aims to investigate the sugar content	NA (full-text not accessible)	65

Tiwari (2020)	<i>Current Opinion in Pediatrics</i>	India	Review	Adolescents	Not reported	Not reported	of current sports supplements available in the UK.	
Truzzi and colleagues (2020)	<i>Nutrients</i>	Italy	Observational and in vitro	Dietary supplements (dry apple / blueberry extracts); Caco-2 human epithelial cell lines	2	Laboratory analysis and experimental	To spread awareness about poorly regulated supplements and their effects on the health of adolescents, to minimise medical hazards. The widespread use of DS among adolescents, in the background of lack of knowledge and medical guidance, predisposes adolescents to significant health risks. The lack of regulation of supplements encourages contamination and ensures indiscriminate, easy access.	71
Tsartsou and colleagues (2020)	<i>Hormones</i>	Greece	Observational	Adults	358	Online questionnaire	To evaluate the effect of 2 distinct phenolic compounds, using a new in-vitro intestinal wall model in order to understand whether polyphenol effects on humans were related to their concentration. Results suggest the idea that high ingestion of polyphenols could induce negative effects on the intestinal wall's integrity.	70

<u>Verma and colleagues (2019)</u>	<i>Indian Journal of Dermatology</i>	India	Case control	32-year-old male	1	Medical notes	toward the use of dietary supplements and fortified foods.	principles of healthy eating, considering DS/FF as valid additives conferring beneficial effects. Consumers express a degree of wariness as to product labeling and health claims. Finally, they prefer to purchase DS/FF from pharmacies.	Further investigation showed that, the common ingredients within the culprit multivitamins were FA, niacinamide, calcium pantothenate, vitamin C, and biotin. It is highlights the importance of including “over-the-counter” health supplementation while eliciting drug history in case of adverse drug events.	63
<u>Volf and colleagues (2020)</u>	<i>Agronomy Research</i>	Russia	Observational	Sports nutrition products	5	Laboratory analysis and product audit	To study the quality and safety of some sports nutrition products.	The results obtained in the course of the work showed that in almost all of the studied samples are content of epoxides ($7.5\text{--}47.6\text{ g}^{-1}$) and		70

<u>Wawryk-Gawda and colleagues (2018)</u>	<i>Przeglad Epidemiologiczny</i>	Poland	Observational	Medical students	611	Online questionnaire	To analyse the frequency of dietary supplements use by young people, their knowledge, and the assessment of the effectiveness of dietary supplements by those who consumed these products.	secondary oxidation products – 1% or more. DS are commonly consumed by young people regardless of the fact that many do not observe any DS intake-related improvement of their health. The knowledge about the effects of DS and their adverse effects is relatively high. Yet, many people do not know the difference between a medication and DS. There is a need for greater awareness of the risk of DS misuse.	62
<u>Yang and colleagues (2020)</u>	<i>International Journal of Cardiology</i>	China	Case control	Pregnant females	150	Medical notes	To explore the associations of maternal iron intake during pregnancy and maternal and neonatal iron status with congenital heart disorders.	Mothers whose fetuses have CHD are less likely to have higher intakes of total iron and heme iron and take iron supplements during pregnancy compared to their counterparts. Maternal iron status before delivery is low among mothers whose fetuses have CHD.	65

<u>Yeung and colleagues 2018</u>	<i>Oncology</i>	US	Review	Previous publications	Not applicable / available	Review	This article focusses on “herbs” used by cancer patients and survivors. These products are derived from botanical sources used as traditional medicine, dietary supplements, food or spices.	We highlight four popular herbs and a medicinal mushroom commonly used by cancer patients- turmeric, green tea, ginger, ashwagandha, and reishi mushroom- along with reports of their interactions with standard drugs. We conclude by emphasizing the need to inform patients and physicians about herb-drug interactions and how to advise patients on appropriate use of herbal supplements to minimize the risk for interactions.	68
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Note:

Publications are listed alphabetically by first author surname; studies were excluded that only reported on whole foods (Newsletter 59 August 2019 to Newsletter 70 August 2020).

Where information was not applicable or available (for example if the full text was not accessible), this is noted in the table.

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