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How to preserve healthy aging through nutritional strategies: the new approach of the Food Social Network (Food NET) project.

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Abstract:	<p>Background. Aging is a process that does not refer only to the accumulation of damage in a human being over time but rather to individual changes determined by genetic, lifestyle, social and environmental factors. Aging is one of the greatest known risk factors for most human diseases. An older person in good health has a good level of independence, weighs less on the national health system and plays a productive and active role in his/her community; thus, the concept of "healthy aging", reflecting older adult-environment fit should be promoted. The interactions between lifestyle, including nutrition, and health play a fundamental role in the aging process; eating habits and eating behaviours are recognized as important modifiable factors potentially leading to a healthy "phenotype".</p> <p>Objective and Methods. A multidisciplinary consortium with three Italian universities (the University of Milano-Bicocca, University of Pavia and University of Calabria) and Italian Small-Medium Enterprises proposed the Food Social Network (Food NET) project. Food NET overall outcome is to achieve target-specific guidelines and exact technologies for accessible functional foods, aimed at improving the quality of life and nutritional status of citizens (aged>65) of the Metropolitan City of Milan (Italy).</p>

	Conclusions. This project is part of the "Smart Living" and food-related strategies aimed at responding to the needs of this target population, developing new food products, appropriate to meet the specific requirements and ensuring and promoting sustainable diets for healthy aging by effective food policy approaches.
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1 **How to preserve healthy aging through nutritional strategies: the new approach of the Food**
2 **Social Network (Food NET) project.**

3

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25

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31 system and plays a productive and active role in his/her community; thus, the concept of "healthy
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45 food policy approaches.

46

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48 Policy,

49

50

51 **Introduction.**

52 Population aging is one of the most significant demographic phenomena of the 21st century
53 all over the world (1). Demographic change is an undeniable reality especially in Europe (2). Indeed,
54 at the beginning of 2018, 101.1 million older people (over 65 years) lived in the EU, equivalent to
55 nearly one fifth (19.7%) of the total population (2); this trend is expected to rise over the next three
56 decades, reaching a peak of 149.2 million inhabitants in 2050, with a relative share of the total
57 population projected to reach 28.5% (2).

58 Aging is a process that does not refer only to mere personal data but rather to genetic, lifestyle,
59 social and environmental factors (3). From a biological point of view, aging is characterized by i)
60 progressive loss of cellular functionality and disadvantage resulting from environmental stress
61 maladjustment and defence reduction; ii) decrease of functional reserves capacities and compensation
62 mechanisms efficiency (3). Aging, despite being a physiological condition, is responsible for body
63 composition modification with muscle mass and strength decrease, which affects motor capacity
64 leading to a consequent reduction of spontaneous and planned physical activity (3). Aging also results
65 in loss of sensorial functions that in turn may also increase cognitive impairment and impact motor
66 capabilities (3). Furthermore, defences disruption makes aging a high-risk phenomenon for the onset
67 of numerous diseases, negatively affecting physical, psychological and social well-being (3).

68 Even if demographic changes severely affect society, especially public health and the retirement
69 system, as reported by the European Commission (2) on the other hand they offer great opportunities
70 for social interactions and aspirations (4). Indeed, a longer lifespan represents an important window
71 of opportunity, not only for the older adult and their families but also for societies as a whole, since
72 longevity offers a unique chance to set new goals, including higher education or long-neglected wish
73 fulfilment, making a valuable contribution to families and community (1).

74 However, it is important to acknowledge that the achievement of these goals is largely subordinate to
75 health (1). An older person in good health has a high level of independence, weighs less on the

76 national health system (NHS) and plays a productive and active role in the membership community
77 (5).

78 Therefore, the concept of "healthy aging", reflecting older adult-environment fit, plays a key role in
79 our society and should be promoted (5).

80 Over the years, there have been numerous attempts to give a clear definition of healthy aging that was
81 defined as "*the process of developing and maintaining functional capacities that enable well-being*
82 *in old age*" (5). WHO report (4) also stresses that "functional capabilities" are determined by
83 "intrinsic capabilities" (e.g. physical, mental and psychosocial abilities of the individual) and
84 "environmental characteristics" (e.g. political, economic and social norms, values and resources,
85 presence/absence of inequalities, accessibility to health systems) interactions. This definition
86 recognizes healthy aging as a dynamic process rather than a threshold state of presence/absence of
87 health (5).

88 Today, nutrition and health interactions, as parts of the aging process, are broadly investigated both
89 from a scientific and clinical perspective and dietary habits as well as eating behaviour is
90 acknowledged as important modifiable factors that can help to achieve and maintain a healthy aging
91 "phenotype" (6). Indeed, in modern society, the older adult, which embodies people aged 65 and older
92 (4) is considered more vulnerable to inadequate nutrition than younger adults, since dietary intake in
93 this target population is strongly influenced by clinical, social, environmental and economic factors
94 (6).

95 From a biological perspective, aging is characterized by a low-grade inflammation, supported by
96 altered oxidative balance and endocrine patterns modification contributing to significant changes in
97 body composition, metabolism, immune response, neurocognition, and atherosclerosis and insulin
98 resistance resulting in an increased risk of cardiometabolic diseases (7). According to the Academy
99 of Nutrition and Dietetics (8), the whole older adult, and not just the fragile, malnourished or sick
100 ones, should have access to adequate nutrition and appropriate nutritional services. To ensure healthy
101 aging and minimize diseases and disability outcomes, specific medical interventions are needed,

102 including dietary guidelines and recommended nutrient intake fulfilment. However, to preserve an
103 adequate nutritional status in the older adult, numerous other factors should be considered, such as
104 sensory and cognitive aspects, as well as social and cultural factors (9) (figure 1), which finally impact
105 the quality of life (QOL).

106 Studies so far conducted on QOL perception in this population showed that social condition and
107 physical living environment play a key role, alongside health (9). Evidence underlines that the
108 context, which the older adult lives, does matter. Furthermore, the urban food system and food choices
109 relationship based on expected health benefits have an intricate and multidisciplinary connotation
110 inextricably knitted to the cultural background, which must be considered whether there is an
111 intention to identify target-specific and effective public health interventions.

112 The Food Social Sensor Network (Food NET) project aims at satisfying the nutritional
113 requirements of urban senior citizens by providing new food products more adequate to target specific
114 consumers' needs, as well as short-term and long-term food policies to reduce the risk of food
115 insecurity in the older adult. This manuscript provides a brief overview of the novel approach for
116 healthy aging promotion embedded in the Food NET project.

117 ***Healthy Aging and nutrition: medical aspects.***

118 Epidemiological evidence suggests that optimal nutrition plays a beneficial role in healthy
119 aging and age-related disorders, also called Non-Communicable Diseases (NCDs), including
120 cardiometabolic, neurodegenerative diseases and cancer (9).

121 However, as previously described (6), studies conducted on nutrients, single foods or food groups are
122 very challenging starting from the possible endless interactions between dietary components that
123 complicate the interpretation of outcomes both in prevention and treatment. Indeed, the isolated effect
124 of a single food or nutrient may not be valid when it comes to maintaining a healthy aging phenotype
125 as this can cover a combination of different pathways (6). Again, in metabolic processes, foods and
126 nutrients interact, acting in synergy or antagonism (6). For this reason, nutritional studies have shifted

127 focus from individual nutrients or food components to whole diets or dietary patterns, as they better
128 account for interactions that are often difficult to identify (6,9). For instance, it has been well
129 established (10) that Mediterranean dietary pattern (Mediterranean Diet, MD) has a beneficial impact
130 also in the older adult suffering from chronic conditions related to cardiometabolic disorders as well
131 as in mitigating risks related to mood disorders, including depressive symptoms (10). Similarly,
132 adherence to the Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet,
133 combining characteristics of the Dietary Approach to Systolic Hypertension diet (DASH), for blood
134 pressure reduction and the MD with increased consumption of berries and green leafy vegetables,
135 reported to be associated with a lower incidence of Alzheimer Disease, cognitive decline and
136 subjective memory complaints (11). Besides the importance of specific dietary patterns to reduce the
137 age-related disease risk, the use of functional foods also looks promising in the older adult (12). It is
138 well known that functional foods, defined as any food in which definite macro- or micro-nutrients
139 have been added for a specific functional purpose, may prevent or mitigate some pathological issues
140 (12). In the older adult, functional foods are often perceived as healthier than conventional ones and
141 the willingness to consume them is generally high (12). As previously hypothesized (12), this may
142 be explained by the higher concern of the older adult with health and awareness of the beneficial
143 impact of nutrition on health, however, there are also several barriers to functional food acceptance
144 that should be acknowledged, including consumer's expectation on taste, cost of the products and
145 presence of non-natural ingredients.

146 Based on this knowledge, one of the Food NET main objectives was to identify different types
147 of nutritional needs, considering also health status and other lifestyle variables (e.g. quality of sleep,
148 physical activity and smoking habits) of a cohort of 1066 senior citizens (active and independent
149 people) over 65 years of age, living in the metropolitan area of Milan, Italy. To achieve this goal,
150 different lifestyle variables were considered, by using previously validated questionnaires (13-15)
151 while general information, including health status (medical history and medications), methods of food
152 preparation and smoking habits, have been proposed to be investigated using a structure interviewed

153 with multiple-choice/open-ended questions under the supervision of trained personnel. Adherence to
154 a specific dietary pattern, including the Mediterranean Diet and the MIND dietary pattern, has been
155 proposed to be investigated by validated questionnaires (11, 16). Moreover, anthropometric variables,
156 body composition and muscle strength were assessed.

157 The collected data were used to profile the nutritional status of the senior citizen, assessing macro or
158 micronutrient deficiencies or inadequacies useful to identify functional foods not only to supply
159 vitamins and minerals requirements but also to support their overall health status. Indeed, in Food
160 NET, particular attention was given to innovative food fortification, exploiting plant matrixes rich in
161 phytochemicals able to prevent phenomena associated with aging processes such as inflammation,
162 oxidative stress and/or immune system response modulation. Specifically, the project envisages an
163 agrifood sustainability approach aimed at the exploitation of minor agricultural species and food
164 waste rich in compounds of nutraceutical interest. The selection of phytochemicals was carried out
165 by targeting the nutritional needs of the senior citizen, while the extraction of the compounds was
166 based on modern destructive technologies. More specifically, secondary metabolites such as
167 glucosinolates and polyphenols have been selected for their anti-oxidant and anti-inflammatory
168 activities and extracted from different plant matrixes to empower a circular economy perspective of
169 by-products valorisation, but also considering their bio-availability while targeting specific organs or
170 tissues (e.g., after being processed by digestion). The ultimate goal is to design functional foods to be
171 enriched with these phytochemicals, once their ability to reach specific tissues and to exert their
172 nutraceutical properties has been verified.

173 ***Healthy aging and nutrition: sensory and cognitive aspects***

174 The binomial nutrition- *healthy aging* should not only consider dietary intake and nutritional
175 requirements also but also sensory, cognitive and emotional functions.

176 The older adult presents a progressive decline in the main sensory, memory and cognitive functions,
177 which has a strong impact on eating behaviour and the sense of taste (17). It is worth noting here that

178 our sense of taste should be considered within a multisensory context. In other words, what we
179 consider taste is a complex process derived from the interaction between chemical (taste and
180 olfaction), visual, tactile and auditory information in our brain (18). Moreover, taste does not only
181 depend on the food itself but also the eating context and people expectations (19). Therefore, it
182 becomes clear that in healthy aging multiple factors may affect people's dietary habits and
183 perceptions. Aging may coincide with a declining gustatory function that can affect food choices at
184 first and thus dietary intake with potentially negative health consequences (17). Loss of taste is mainly
185 caused by physiological changes (e.g., impaired olfactory acuity) and sometimes worsened by age-
186 related events, such as polypharmacy and chronic diseases (20). Although researchers are still
187 debating on the degree and type of taste loss experienced by an older adult, they all agree that sour
188 and bitter tastes are likely the most affected (20). Again, several nutritional surveys have reported a
189 significant prevalence of sweet foods (often soft and palatable) in the older adult habitual diet with
190 possible health consequences due to excessive intake of sugars and energy leading to hyperglycaemia,
191 obesity and related metabolic diseases (21). Likewise, it has been reported that older adults who have
192 difficulty detecting salty flavours increase their consumption of salty foods and season with more salt
193 (21). Noteworthy, the experience of taste arises from multiple sources of information and sensory
194 impairments in sight, hearing and smell and can contribute to a deterioration in taste perception (21);
195 the loss of the visual, tactile and auditory components of the perception of food, as well as the loss of
196 smell, significantly affect appetite, nutrition, physical and mental well-being (21).

197 Cognitive and emotional aspects also affect people's diet and food-related behaviours. For example,
198 it has been shown that memories of past eating experiences affect food preferences, consumption and
199 emotions and are likely to influence attitudes toward foods as well as everyday food-related
200 behaviours (22). Scientific results have even shown that attention, memory, language and
201 metacognitive knowledge of personal capabilities can influence the results of sensory evaluations
202 about food (23). Once again, the relationship between cognitive functions and food behaviour is
203 reciprocal, with dietary habits and food choices also affecting these functions. Although several

204 studies concentrated on the effect of poor diets in the early stage of life (prenatal or first months of
205 life) (24), growing evidence suggests significant effects of this variable during life span (25). For
206 example, it has been reported that short-term consumption (1–7 days) of an unhealthy diet (e.g., high
207 saturated fat and/or high sugar) triggers neuroinflammatory processes in adults (25). Similarly, adults
208 who consumed a high-fat diet showed a reduction of focused attention and deficit of episodic retrieval
209 (ER) and working memory (WM), after just 5 days from dietary change compared with those who
210 consumed a standard diet (26). Perhaps the passage of long-chain saturated fatty acids into the
211 hypothalamus - one of the main brain structures of our memory system – also contributed to this
212 phenomenon, ensuing an inflammatory response (27).

213 The above-mentioned evidence supported the integration of sensory, cognitive features and
214 memory among the medical aspects to be considered in this cohort of *free-living* older adult
215 volunteers enrolled in the Food NET project, suggesting that the assessment of neuro-cognitive and
216 historical-biographical factors related to nutrition would help to design personalized tailored
217 interventions, effective for improvement of health and wellbeing. In particular, neuropsychological
218 and psychometrical tests (28) are useful to identify how age and cognitive decline might affect taste
219 detection, unisensory, and multisensory flavour perception (throughout the combination of visual,
220 olfactory, acoustic and gustatory stimuli). Furthermore, it is worth verifying whether food choices are
221 more influenced by emotional rather than rational variables.

222 Changing people’s behaviour (and maintaining such change) is not a simple matter (29); changing
223 eating habits, especially in older adult, requires a deep consideration of a large number of variables,
224 including sensorial, cognitive, motivational and emotional ones. This is why the investigation of such
225 factors has been included in the Food NET project to complete senior citizens profiling and tailor
226 effective strategies to improve people’s diets, throughout the historical-biographical assessment,
227 including interweaving of representations, experiences, images and memories that substantiate the
228 experience of the older adult and guide their eating habits and dietary patterns. The survey, based on
229 semi-structured questionnaires and medical history on a subsample of the target population, aimed at

230 identifying how internalized educational models, experiences and emotional processes affect dietary
231 pattern and quality of life.

232 These data are essential not only to tailor adequate nutritional interventions for citizens over 65 but
233 also to promote healthy habits and provide a continuous care model establishing and maintaining a
234 dynamic, flexible and continuous track to improve the citizens' lifestyle.

235 The results are also useful to define the most accepted palatability characteristics, considered pleasant
236 by the subjects, to design functional foods that will likely be consumed to ensure greater effectiveness,
237 affecting marketing methodologies.

238 ***Healthy Aging and nutrition: social and cultural aspects***

239 Another important dimension to be considered, while discussing nutrition and the healthy
240 aging domain, is food insecurity that affects food choices and dietary habits.

241 Food insecurity is described as the uncertain or limited physical, social and economic access of
242 individuals and families to sufficient, safe, nutritionally adequate and culturally relevant food (30); it
243 affects not only low-income countries but also developed ones, especially in some vulnerable groups,
244 such as the older adult (31). Food security is closely linked to well-being as nutrition, food and food
245 activities are associated with benefits in terms of health, identity-building processes and social
246 participation (30). The older adult may experience several constraints that hinder their ability to
247 access healthy foods, such as physical and mental disabilities that prevent them from accessing food,
248 due to decreased mobility (31), or long walking distance from the markets, as well as a lack of private
249 transport mode or a reliable and efficient public transport (32). A growing body of evidence also links
250 food insecurity to higher rates of certain mental and physical health conditions, including depression,
251 anxiety, diabetes and hypertension, as well as higher health care costs (33). Food insecurity worsens
252 the nutritional status, leading to negative health outcomes, especially in people where some diseases
253 are strictly diet-dependent, such as diabetes or high cholesterol, which are more common in the older
254 adult (33). Additionally, individuals living in food-insecure households have cost-related non-

255 adherence to medication, which likely reflects trade-offs between food purchases and other basic
256 needs, such as medication (33).

257 Among the various factors to guarantee access to food, there is a widespread presence on the territory
258 of markets in which to obtain fresh food (34). However, when this is not guaranteed, food desert
259 occurs (35), described as geographical areas where residents' access to affordable and healthy food
260 options (especially fresh fruit and vegetables) is limited or non-existent due to the absence of grocery
261 stores within walking distance (34). Other studies suggest going beyond a simply transportation
262 perspective and to put more emphasis on the social, subjective and cognitive aspects of being mobile.
263 Besides spatial accessibility and geographical distance, other studies highlight the importance of the
264 social, subjective and cognitive dimensions of access to food (36). For instance, the perception of
265 insecurity, the loss of cognitive familiarity with the residential environment are factors that can hinder
266 the movement of the elders and their access to food. In this sense, the older adult's ability to reach
267 affordable and healthy food is more related to the age-friendly degree of the residential environment
268 (37).

269 Besides, the eating habits of older adult are also influenced by other factors, such as the grief for the
270 loss of life companions. Such kind of event has been related to subsequent poor nutrient intake and
271 diet quality (32); older adult widowers are indeed at greater nutritional risk than married ones (38).
272 Furthermore, socioeconomic status affects dietary habits with lower incomes associated with reduced
273 diet quality (39). Economic and public health evidence suggests a relationship between food prices
274 and dietary patterns (39); indeed, based on the price per calorie, fresh products are more expensive
275 than energy-dense processed foods (39). Furthermore, previous results highlighted that food price
276 impacts food choice and greatly affects individuals from low-income areas (32).

277 Starting from this knowledge, the Food NET project aimed at assessing food insecurity in the
278 metropolitan city of Milan by identifying the barriers that hinder senior citizen's food access,
279 according to their characteristics. In particular, in the analysis of food accessibility, a location-based
280 specific walkability index (40) was adopted and applied. Briefly, the index synthesises the main

281 factors associated with pedestrian mobility, such as food stores density and attractiveness of services
282 for older people (e.g. pharmacies, community and social centres, unions of pensioners, physicians,
283 green areas), the connectivity of the road network and the incidence of walkable roads within
284 distances accessible on foot (the maximum threshold used corresponds to a 12-minute trip at a speed
285 of 0.9 m/s) (40). In the Food NET research, information on food accessibility and environmental
286 perceptions, the commute modes to reach food destinations as well as the relational context of
287 commuting, purchasing and consuming food, have been collected on a representative sample of
288 volunteers. Senior citizens profiling was completed by the analysis of social participation and other
289 socio-demographic variables (e.g., age, sex, household type, socio-economic status). The results were
290 then exploited to support urban food policy by identifying potential food deserts within the
291 metropolitan city as well as the age-friendliness of the residential food environment. Furthermore,
292 the attention paid to the social and individual dimensions of food access has favoured the definition
293 of more appropriate interventions for improving access to food and QOL of senior citizens.

294 **Methods: The Food NET project**

295 Food Social Sensor Network (Food NET) (<http://www.food-net.it/>) is a multidisciplinary
296 project bringing together three Italian Universities (University of Milano-Bicocca; University of
297 Pavia; University of Calabria) and nine Small-Medium Enterprises (SME) of Lombardia Region
298 (Aton Informatica, <http://www.atoninformatica.it>; Amita Health Care Italia,
299 <https://www.amitahc.com>; Balance, <https://balanceconsulting.it>; Complife Group,
300 <https://complifegroup.com>; Design Group Italia, <http://www.designgroupitalia.com>; EPO-Estratti
301 Piante Officinali, <http://www.eposrl.com>; FEM2-Ambiente, <https://www.fem2ambiente.com>;
302 Flanat Research Italia, <http://www.flanat.com>; IT Food).

303 The overall outcome is to achieve specifically targeted guidelines and exact technologies for
304 accessible functional foods, aimed at improving the quality of life and nutritional status of the free-
305 living older adult (aged>65) in the Metropolitan City of Milan (Italy).

306 The project benefits from a well-constructed *consortium* with many universities with expertise in the
307 field of nutrition, sociology, botany, chemistry, cellular biology and psychology as partners, besides
308 some small and medium enterprises with competencies in different fields, such as medicinal plants,
309 molecular identification of species, nutraceutical products formulations, design, informatics and
310 digital technologic processes.

311 ***How Food NET preserve healthy aging through nutritional strategies?***

312 The “World Report on Aging and Health” (5) not only defined healthy aging but also identified the
313 actions necessary for its achievement or maintenance through the improvement of intrinsic and
314 functional capabilities. Among these actions, the report indicates the importance of i) aligning health
315 systems to the real needs of the older adult population, building multidimensional and integrated
316 systems able to take into account the frequent comorbidities occurring in the older adult and ii)
317 including them in intervention and observational studies to monitor their health status and needs (5).
318 Food NET aims to undertake both actions through i) identification and interpretation of specific target
319 consumers’ nutritional needs ii) identification of novel favouring process and product innovation by
320 agro-food companies and iii) implementation of both nutritional status and quality of life of senior
321 citizens through functional foods, nutritional models and educational processes aimed at achieving
322 and maintaining healthy aging.

323 To achieve these objectives, the project comprises three phases, i) Evaluation, ii) Reaction and iii)
324 Restitution, besides five work packages (WPs) (figure 2).

325 *Phase 1: Evaluation*

326 This phase was planned to address the nutritional status of the senior citizen and develop context-
327 specific indicators, including dietary, nutritional, cognitive, emotional, cultural and socio- territorial
328 features that measure healthy aging. All these activities were supported by an ICT platform containing
329 and interpreting the older adult nutritional needs (e.g. nutritional status, dietary patterns and food
330 insecurity aspect) and other cognitive, sensitive, personal, historical aspects obtained through

331 surveys. These data were then standardized and aggregated into a single dataset to allow the execution
332 of scripts that calculate statistical indices on the answers provided by each user. A fixed score was
333 assigned to each answer for the calculation of further statistical indices. Besides, the ICT platform
334 contains a series of data that have been appropriately collected, modified and integrated through more
335 than 30 automatic processes developed to collect different types of information. For example, data
336 about large and medium-sized authorized sales structures, pharmacies, food groceries store and
337 markets, public transport in Milan (e.g. surface line stops and timetables, underground stops and
338 routes) were collected, filtered, cleaned of non-essential information and saved.

339 *Phase 2: Reaction*

340 The *Reaction* phase was planned to design, implement and evaluate the efficacy of functional foods
341 able to address specific target nutritional needs identified in the *Evaluation* phase as well as measuring
342 the impact of food efficacy and lifestyle changes over time. In this context, the acceptability and
343 hedonic aspects of food have been also taken into account in the design of functional food.

344 The overall purpose was to structure an organized industrial chain from raw materials to food products
345 to provide and test new foods (functional food) for consumers' specific requirements. Secondary
346 objectives i) to identify and extract bioactive phytochemicals (also from waste vegetable matrices) to
347 produce functional foods; ii) to identify eco-sustainable procedures to optimize bioactive compounds
348 extraction also from industrial waste; iii) to build innovative technical-scientific infrastructure, named
349 "Food-omics platform" to identify and develop functional foods.

350 The Food-omics platform was made up of analytical facilities aimed at isolating and testing the
351 efficacy of nutraceutical products of plant origin (i.e., high throughput extraction systems of
352 secondary compounds from plant wastes or raw matrixes; mass spectrometry and NMR based
353 analytical systems for the chemical detection and quantification of phytochemicals; *in vitro* and *in*
354 *vivo* model systems to investigate the bioactivity of isolated compounds and/or phytocomplexes).

355 Food NET suggests sustainable solutions to improve nutritional status in the older adult, using new

356 healthy safe and palatable food products (e.g. snacks, supplements, etc.), in response to market
357 demands by ensuring access to nutritious foods through a personalized nutritional approach.

358 *Phase 3: Restitution*

359 The *Restitution* phase was planned to tackle several aspects, including food policy, education,
360 academic training and public engagement. For this reason, Food NET intends to i) defining
361 operational actions for territorial governance, supporting the Municipality of Milan in the field of
362 food and nutrition policies; ii) applying the Food-omics infrastructure through the spread of best
363 practices and expertise for food safety control in the production system supporting product innovation
364 activities; iii) developing advanced training actions to create new professionals with agro-food,
365 nutritional and healthcare skills; iv) targeting specific educational software packages for smart
366 devices (e.g. mobile-app) at the population-wide level to increase the awareness and to promote a
367 healthy eating and lifestyle (smart living). In particular, the mobile app was conceived with the dual
368 purpose of increasing food awareness redefining the eating habits of the senior citizen and creating
369 social engagement by providing information and encouraging their sharing. Indeed, introducing a
370 social engagement component makes it possible to build a community focused on food wellbeing and
371 a healthy lifestyle; sharing and discussing with other people is considered as an engaging element
372 able to support users in improving their habits.

373 **Conclusion**

374 In summary, interactions between nutrition and health play a fundamental role in the aging process;
375 eating habits and behaviours are acknowledged as important modifiable factors that help in achieving
376 and maintaining a healthy "phenotype". The Food NET project fits perfectly into the context of
377 healthy aging taking care to prevent or slow down the development of NCDs and to increase
378 awareness of the importance of healthy habits in the population. The project takes up the challenge
379 by contributing to developing smart living environments for aging people who are the most exposed

380 to inaccessibility to food resources and malnutrition risk, with serious effects on health, well-being
381 and social participation.

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502 **Figures**

503 **Figure 1. Nutrition and healthy aging.**

504 **Legend.** Nutrition in the older adult plays a pivotal role in achieving and maintaining a healthy aging
505 "phenotype ". To ensure the health and minimize diseases and disability outcomes, specific medical
506 interventions are needed, including dietary recommendations and nutrient intake goals. However, to
507 preserve an adequate nutritional status in the older adult numerous factors should be additionally
508 considered such as sensory and cognitive aspects, as well as social and cultural factors.

509

510 **Figure 2. Food NET project structure: three phases and five work packages.**

511 **Legend.** The Food NET project comprises three phases, i) Evaluation, ii) Reaction and iii)
512 Restitution, besides five WP. Evaluation (WP1) aimed at the targeting nutritional status of the free-
513 living older adult and at developing context-specific indicators, that measure healthy aging. This
514 activity is planned to be supported by an ICT platform able to interpret the senior citizens' nutritional
515 needs. Reaction (WP2-WP4) aimed at structuring an organized industrial chain from raw materials
516 to finished food products (functional food) for the specific requirements of the free-living older adult-
517 specific requirements, as well as measuring the impacts of dietary efficacy and lifestyles changes over
518 time. Restitution (WP5) aimed at tackling several aspects, including food policy, education, academic
519 training and public engagement.



