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Do consumers understand health claims on extra-virgin olive oil?
--Manuscript Draft--

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Highlights

- Understanding health claims on food label is difficult for many consumers.

- Consumer understanding of the health claims applicable to olive oil was measured.

- An Olive Oil Health Claims Understanding index was constructed.

- Low understanding of the health claims applicable to olive oil was detected.

- Drivers of consumers understanding were identified and measured.

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Abstract

Health claims have been introduced in food labelling to support consumers' awareness of healthy food choices and to enhance a healthy diet. Even though many countries around the world have developed legislation and guidelines to regulate the introduction of health claims on food labels, there is the evidence that many consumers do not understand the meaning of these claims. This study analyses whether Italian consumers really understand authorized health claims on extra-virgin olive oil and what are the drivers of such understanding. An Olive Oil Health Claims Understanding index was constructed and embedded in a structured questionnaire, which was then administered to a representative sample of Italian household members who are responsible for food shopping (N=1,030). Results from the survey showed that only 36% of the respondents understood the meaning of the authorized health claims on extra-virgin olive oil. Moreover, the findings confirmed that the understanding of health claims is related to socio-demographic, personal and psychographic characteristics of consumers, as well as to their attitudes toward using food as medicine. Outcomes also proved the central role of nutrition knowledge in affecting understanding of health claims.

Key words: health claims; olive oil; food labelling; label understanding; healthy diet; Tobit model

1. Introduction

Nutrition and health claims may be applied on food packaging to support consumer awareness of healthy food choices and to enhance a healthy diet (Cooke & Papadaki, 2014; Leathwood et al., 2007; Karelakis et al., 2020). Health claims are defined as "*any claim that states or implies a relationship between food (or its constituents) and health*" (Buttriss & Benelam, 2010).

Many countries around the world have developed legislation and guidelines to regulate the insertion of health claims on food labels (Díaz, Fernández-Ruiz & Cámara, 2020). In fact, before the introduction of Regulation No. 1924/2006, guidelines for using health claims differed from country to country across the European Union (Gilsenan, 2011; Hieke et al.,

32   2016). In 2012, Commission Regulation No. 432/2012 established a harmonized list of

33   authorized health claims.

34   The European Regulation No. 1924/2006 sets down two general requirements with regard to

35   consumer protection: 1) "*health claims must be not false, ambiguous or misleading to*

36   *consumers*"; 2) "*the use of nutrition and health claims shall only be permitted if the average*

37   *consumer can be expected to understand the beneficial effects as expressed in the claim*"

38   (Grunert et al., 2011). With regard to the second requirement, "*the average consumer*" is

39   defined as a consumer "*who is reasonably well informed and reasonably observant and*

40   *circumspect*" (Leathwood et al., 2007).

41   The existing literature has identified several problems relating to the complex processes

42   involved in the understanding of health claims (Bellumori et al., 2019; Di Fonzo et al., 2020;

43   Finardi et al., 2009). Interest in the subject stems from evidence that many consumers do not

44   understand the meaning of claims about foods (Grunert et al., 2011; Pinto et al., 2017) and do

45   not distinguish one type of claim from another (Nocella & Kennedy, 2012; Van Trijp & Van

46   der Lans, 2007). Using diverse approaches, many researchers have attempted to shed light on

47   the reasons why consumers find health claims difficult to understand (Cowburn & Stockley,

48   2005; Drichoutis et al., 2006; Grunert & Wills, 2007; Grunert et al., 2010; Hung et al., 2017).

49   In general, these studies show that the level of understanding changes depending on the type

50   of product considered and also varies across countries (Carrillo et al., 2014; Lähteenmäki,

51   2013; Steinhauser & Hamm, 2018; Van Trijp & Van der Lans, 2007). Moreover,

52   understanding of health claims has been related to the specific content, wording and format of

53   these claims (Ares et al., 2009; Grunert et al., 2011). Consumers seem to prefer short and

54   succinct claims with simple and general information about the potential benefits of food

55   products (Nocella & Kennedy, 2012; Kapsak et al., 2008). Other studies have focused on the

56   personal factors that influence consumers' understanding of health claims. Some authors have

57   demonstrated that there is a relationship between understanding of nutrition claims and

58   personal factors such as nutrition knowledge, attitudes and demographic characteristics

59   (Cooke & Papadaki, 2014; Drichoutis et al., 2006; Grunert et al., 2010; Grunert & Wills,

60   2007; Misra, 2007; Rasberry et al., 2007; Vidigal et al., 2011).

61   This study contributes to this literature by analysing whether Italian consumers really

62   understand authorized health claims on extra-virgin olive oil (EVOO) and what are the drivers

63   of such understanding.

64 To achieve these goals, an Olive Oil Health Claims Understanding (OOHCU) index was

65 constructed. The index was based on select and specific questions about the authorised health

66 claims for EVOO drawn up by a group of academic experts in different disciplines (i.e.,

67 medical doctors, pharmacologists, nutritionists and food scientists).

68 The authorised health claims for EVOO are four: three of them have been approved as

69 "functional claims" (Art.13 (1) of Reg. (EC) 1924/2006), while the fourth has been classed as

70 a claim for "reduction of disease risk" (Art.14 (1)(a) of Reg. (EC) 1924/2006) (see **Table1**,

71 adapted from Roselli et al., 2017).

72

73 [INSERT **TABLE 1** HERE]

74

75 The reason to undertake the present study on understanding of health claims on EVOO stems

76 from several observations. EVOO is a key element of the Mediterranean diet and its

77 popularity is increasing worldwide (Cicia et al., 2013; De Graaff & Eppink, 1999; Owen et

78 al., 2000). At the same time, the international olive oil market is characterized by increasing

79 competition, which encourages producers to differentiate their products (Roselli et al., 2017).

80 In the current scenario, which is characterized by consumers' growing concern about the

81 relationship between food choices and health (Bimbo et al., 2016; Grunert, 2005; Urala &

82 Lahteenmaki, 2004), a key to competing in the olive oil market could be to identify, promote

83 and increase high quality products that are characterized by high health value (Roselli et al.,

84 2017). Evidence from the United States and Europe indicates that the introduction of health

85 claims can increase the market share for different products (Heasman & Mellentin, 2001). At

86 the moment, however, the olive oil sector has not benefitted from health claims, probably due

87 to a general and widespread difficulty among the average consumer in understanding

88 unfamiliar, scientific terms involved in these claims (Roselli et al., 2017).

89 Drawing on previous studies, we distinguish between two levels of analysis: the first step is to

90 explore how the understanding of health claims on EVOO is distributed across the Italian

91 population, while the second step concerns the identification of the variables that influence

92 the overall understanding of the four health claims. The variables considered are socio-

93 demographic, personal, psychographic characteristics (i.e., nutritional importance and

94 subjective nutritional knowledge), nutrition knowledge and attitudinal scales ("general health

95 interest" and "attitudes towards using food as medicine"). To the best of our knowledge, this

3

96   is the first study conducted in Italy and based on a nationally representative sample that aims

97   to analyse understanding of the authorised health claims for EVOO.

98

99   **2. Material and methods**

100   In 2019, a professional marketing company administered an online, structured questionnaire

101   to a representative sample of Italian household members who are responsible for food

102   shopping (N=1,030). Participants were stratified according to gender, age and area of

103   residence.

104   The protocol used for data collection complied with national ethical requirements. In

105   particular, all subjects gave their informed consent to participate in the study, and all data was

106   collected anonymously. All data was also recorded and managed according to the "Italian

107   Personal Data Protection Code" (Law Decree no. 196 of 30 June 2003).

108   The variables examined are presented below, as well as the hypothesis about their impact on

109   the understanding of health claims.

110   *Understanding of health claims (dependent variable)*

111   This variable refers to whether or not respondents correctly understood health claims on

112   EVOO and, more specifically, the terms employed in articulating these claims. It consists of

113   select and specific questions about health claims. The OOHCU index was constructed by

114   employing questions that a group of experts in different disciplines (i.e., medical doctors,

115   pharmacologists, nutritionists and food scientists) drew up or adopted from previous, similar

116   surveys. The answers to each question were coded as 1, if right, and 0, if wrong. In particular,

117   16 questions (four questions for each health claim) were pre-tested in three consecutive waves

118   of face-to-face interviews, which involved, each time, between 20 and 30 household members

119   who are responsible for food purchasing. The pre-test aimed to evaluate the clarity of wording

120   and the overall complexity of the issues. After each pre-test, questions were revised by the

121   experts to improve their clarity and to ensure an average understanding level threshold. The

122   final version of the OOHCU index was tested through an online survey on a convenience

123   sample comprising 50 household members who are responsible for food purchasing (see

124   Appendix A).

125   Although the OOHCU construction allows to estimate also the understanding index for each

126   of the four authorized health claims on EVOO, this data was not analysed in the current

127   research. Indeed, this study aims to evaluate the overall understanding of Italian consumers of

128 the authorized health claims on EVOO as an entire category. What we want to discover is the

129 general level of consumers' understanding and, consequently, if the implementation of health

130 claims on olive oil bottles has the potential to develop the market of high quality products.

131 *Socio-demographic and personal characteristics*

132 Socio-demographic and personal variables have always placed a central role in the analysis of

133 the determinants of use and understanding of nutritional information (Drichoutis et al., 2005;

134 Grunert et al., 2010). The socio-demographic and personal characteristics of the sample are

135 summarized in **table 2** and **table 3**. The sample of household responsible for food shopping

136 was stratified for gender, age and area of residence. The final sample is younger and higher

137 educated compared to the general Italian population because, as in several similar studies,

138 younger and higher educated individuals are keener to participate and more familiar with the

139 use of internet (Ballco & De Magistris, 2019; Jurado & Gracia, 2017; Verhoef, 2005).

140

141   [INSERT **TABLE 2** HERE]

142   [INSERT **TABLE 3** HERE]

143 *Psychographic characteristics*

144 Participants' psychographic characteristics were measured by means of two blocks, adapting

145 Van Trijp & Van der Lans (2007): "nutrition importance" (2 items) and "subjective nutrition

146 knowledge" (2 items) (see Appendix A). The items for the "nutrition importance" scale were

147 measured on a 7-point scale whose endpoints ranged from never (1) to always (7), while the

148 other scale ranged from strongly disagree (1) to strongly agree (7). Psychographic

149 characteristics have been employed in previous research, aiming to analyse consumers'

150 perception of health claims (VanTrijp & Var der Lans, 2007). The hypothesis (H_1) is that

151 consumers could have different perception of health claims depending on their different

152 psychographic characteristics.

153 *H_1: the higher are both the scores of "nutrition importance" and "subjective nutrition*

154 *knowledge", the higher will be the understanding of health claims.*

155 *Nutrition knowledge*

156 A "nutrition knowledge" index was derived from Parmenter and Wardle (1999). This index

157 was validated to obtain an objective assessment of nutrition knowledge among adults. In this

158 study, we have selected 7 groups of questions from the original scale according to their

159 relevance (Cavallo & Piqueras-Fiszman, 2017) (see Appendix A). The answers to each

5

160   question were coded as 1, if right, and 0, if wrong. The responses allowed the construction of

161   an overall score for each individual, ranging 0 to 17. "Nutrition knowledge" has been

162   demonstrated to have a strong and positive influence on the understanding of health claims

163   (De Vriendt et al., 2009; Grunert et al., 2010; Hendrie et al., 2008).

164   *H_2: the higher the "nutrition knowledge" index, the higher will be the understanding of*

165   *health claims.*

166   *General health interest*

167   The section on attitudes towards healthy eating employs the validated scale of "general health

168   interest" adapted from Roininen et al. (1999). The scale consists of 8 items measured on a 7-

169   point Likert scale, ranging from strongly disagree (1) to strongly agree (7) (see Appendix A).

170   The "general health interest" scale is used extensively in studies of consumers' motivations

171   and attitudes toward healthy habits. It has been used previously to examine the use and

172   understanding of health claims (Dean et al., 2012; Grunert et al., 2010).

173   *H_3: the higher the "general health interest" score, the higher will be the understanding of*

174   *health claims.*

175   *Attitude toward using food as medicine*

176   The scale for assessment of "attitude toward using food as medicine", previously proposed

177   and validated by Dean and colleagues (2012), measures consumers' tendency to use food to

178   resolve health problems related to incorrect diet. This scale consists of three items adopted

179   from Urala and Lateenmaki (2007), while a fourth one is added to underline the relationship

180   between food, health claims and the prevention of illness (Dean et al., 2012) (see Appendix

181   A). "Attitude toward using foods as medicine" scale is used to investigate consumers'

182   perception and attitudes towards food to which health claims are attached. Earlier results have

183   shown a positive influence on consumers' perceived reduction of risk as a result of eating

184   food claimed to be healthy (Dean et al., 2012).

185   *H_4: the higher the "attitude toward using food as medicine" score, the higher will be the*

186   *understanding of health claims.*

187

188   **3. Statistical analysis**

189   This study aims to determine which variables influence the Olive Oil Health Claims

190   Understanding (OOHCU) variable. Therefore, a regression model was estimated assuming the

191   following equation:

193     $OOHCU = X'\beta + e$ (Eq. 1)

194

195 where OOHCU represents the vector of the dependent variable, namely the Olive Oil Health

196 Claim Understanding index, the X' is the matrix of the independent variables, β is a vector of

197 the estimated parameters, e represents the error term.

198 Since a substantial portion of the observations of the dependent variable lie on the extreme

199 values - double censoring - (see **figure 1**), to estimate the β, we applied the Tobit regression

200 model (Tobin, 1958) for consistent and unbiased results. This type of regression assumes that

201 the observed variable, in our case OOHCU, underlies a latent (i.e., unobserved) variable that

202 is normally distributed:

203

204     $OOHCU = \begin{cases} y^* \text{ if } ll \leq y^* \leq ul \\ ll \text{ if } y^* < ll \\ ul \text{ if } y^* > ul \end{cases}$ (Eq. 2)

205

206 where y* is the latent variable and *ll* and *ul* are the limits of the observed variable OOHCU,

207 respectively 0 and 16. The estimation procedure of the coefficients uses the maximum

208 likelihood function.

209

210   [INSERT **FIGURE 1** HERE]

211

212 **4. Results and discussion**

213 *4.1. Understanding of EVOO health claims and attitudinal scales*

214 The analysis of the OOHCU variable describes the general level of understanding within the

215 sample. The OOHCU is calculated by combining the scores on specific questions about health

216 claims on EVOO for a total of 16 questions. Results showed that 24% of consumers had a

217 very low level of comprehension (< 5 right answers); 40% answered correctly five to eight

218 questions; 36% gave right answers to more than 8 questions (more than the half of the

219 questions), 22% answering between 9 and 12 questions correctly and 14% more than 12

220 questions (**table 4**). Similar results were found in a study conducted on probiotic yogurt,

221 where a specific health claim was understood by only 25% of Italian respondents, as

222 compared to 60% in Germany and UK. Different findings were obtained by Grunert and

7

223   colleagues (2010), who found that 67% of respondents had little difficulty in elaborating and

224   understanding the health claims on a functional food product. This suggests that the level of

225   comprehension may be strongly affected by the type of health claim and the type food product

226   at issue, beyond any differences across countries (Leathwood et al., 2007; Van Trijp & Van der

227   Lans, 2007).

228

229   [INSERT **TABLE 4** HERE]

230

231   The results for the variables used to explain OOHCU index are summarized in the following

232   section while **table 5** reports their descriptive statistics.

233   The "general health interest" scale is highly reliable since the Cronbach's alpha is 0.80. The

234   average sample score is slightly below 5 (on a 7 point scale), which implies that respondents'

235   attitude toward healthy eating was positive. Cronbach's alpha for the "attitude toward using

236   food as medicine" scale is 0.87, indicating a high degree of reliability. The respondents' mean

237   score is 5.03, which suggests that they are positively disposed toward using food as medicine.

238   The average score for "nutrition knowledge" index is 9.72, which suggests that nutrition

239   knowledge is not great. In addition, the standard deviation is 3.37, indicating a high degree of

240   heterogeneity within the sample. Respondents score "nutrition importance" highly, the

241   average score being 4.9 on the 7-point scale and the Cronbach's alpha is 0.67. Finally, the

242   average score for "subjective nutritional knowledge" is 4.46 and the Cronbach's alpha is 0.84.

243

244   [INSERT **TABLE 5** HERE]

245

246   *4.2. Drivers of consumers' understanding of EVOO health claims*

247   For the second step of the analysis, the relationship between consumers' understanding of the

248   four health claims on EVOO and the other variables (socio-demographic, personal,

249   psychographic, nutrition knowledge and attitudes) has been formally investigated using a

250   Tobit regression (results are shown in **table 6**). Multicollinearity has been tested via Variance

251   Inflation Factor with all VIF values greatly below the suggested threshold. Therefore,

252   collinearity has been excluded.

253

254   [INSERT **TABLE 6** HERE]

8

The socio-demographic variables, *gender, education* and *EVOO consumption frequency*, were not statistically significant at $p < 0.05$ level.

Regarding the non-significance of *gender*, some authors have found a greater interest among women and noted how women have a positive attitude toward health related messages (De Vriendt et al., 2009; Grunert et al., 2012; Hendrie et al., 2008), while others have not observed any significant difference between genders (Ares et al., 2009; Dean et al., 2012; Urala et al., 2003; Urala & Lähteenmäki, 2007).

The *education* variable seems to contradict the finding of some studies that better educated consumers are more aware of the link between diet, health and disease (Cotunga et al., 1992; Ippolito & Mathios, 1991) and have a better understanding of diet-disease messages than less educated consumers (Fullmer et al., 1991; Moorman, 1990). Other researchers have found instead that interest, and consequently, capacity to understand health claims is rooted in consumers' interest in particular products, rather than in consumers' general level of education (de Jong et al., 2003; Verbeke, 2005). Moreover, more highly educated people are more informed about product features and do not pay great attention to health claims. In other words, this kind of consumer does not orient their preferences on the basis of health claims (Verbeke et al., 2007).

The *EVOO consumption frequency* variable did not influence the understanding of health claims. This variable is an individual level self-estimate (how many times the respondent consumes EVOO in a specific time span). This means that recurring consumption of olive oil does not improve the understanding of health claims on olive oil. Indeed, the sample showed a low variability of consumption habits since most of respondents (87%) reported that they consume EVOO more than once a week. On the contrary, *EVOO consumption quantity* resulted significant. This variable is a more realistic measure of the amount of EVOO consumed by household members during a specific time period (it indicates approximately how many litres the household consumes per month). It is conditioned by several factors such as household size, usage (dressing or cooking), and finally by consumption frequency.

As for personal characteristics, *family members' illness, personal illness* and being *on a special diet* were not significant. These results are out of line with the existing literature, especially in relation to personal illness and illness of relatives. It has been shown that individuals tend to have a more positive attitude toward food products with health claims

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287   when a relative or friend is affected by the condition involved in the claims (Lalor et al.,

288   2011; Wills et al., 2012).

289   Conversely, we found that the variables *age*, *children in the household* and *health condition*

290   resulted to be statistically significant. These results mean that elder people, people with

291   children in the family, and with a low perceived health status, better understand health claims.

292   To be more precise, *age* is significant in explaining understanding of health claims. The

293   existing literature shows that age has a positive influence on the attention to food healthiness

294   and interest in health claims (Contini et al., 2015; Siegrist et al., 2008). Older consumers have

295   a higher capacity to understand messages about the healthiness of food products.

296   The variable *children in the household* is positive and statistically significant. This result is

297   consistent with earlier research which has shown that families with children display a stronger

298   interest in information about nutrition on the label (Contini et al., 2015; Grunert & Wills,

299   2007).

300   The statistical significance of *health condition* means that the lower is the perceived health

301   status, the more respondents are interested in information on the packaging about the

302   healthiness of food, and, consequently, in understanding related messages. This could be

303   interpreted as consumers paying greater attention to health claims when personal health status

304   is not good.

305   The psychographic variables classed as *nutrition importance* and *subjective nutrition*

306   *knowledge* are, consistently with our first hypothesis (H_1), both significant in determining the

307   understanding of health claims. In other words, the higher is the tendency of consumers to

308   choose food for reasons of health and healthy food in general, the more they are capable of

309   understanding health claims. In addition, the more consumers feel both knowledgeable about

310   health and nutritional issues, the better they understand health claims.

311   Consistently with the second hypothesis (H_2), results confirmed the strong effect of *nutrition*

312   *knowledge* in influencing the understanding of health claims. In other words, the higher is

313   consumers' nutrition knowledge, the more they understand health claims. This is in line with

314   previous studies demonstrating that the higher is nutrition knowledge, the more consumers

315   have a positive attitude toward processing and understanding health related information

316   (Banovic et al., 2019; Carillo et al., 2014; De Vriendt et al., 2009; Grunert et al., 2010;

317   Grunert et al., 2012; Hendrie et al., 2008). Moreover, knowledge about products and nutrition

318   information play a fundamental role in highlighting the real meaning of messages (reducing

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319   misunderstanding) and in evaluating the risk of disease (Brennan et al., 2008; Hoch & Ha,

320   1986; Williams, 2005).

321   Lastly, results concerning attitudes are ambiguous, showing as they do that the *general health*

322   *interest* is not statistically significant, but *attitudes towards using food as medicine* does

323   influence understanding of health claims.

324   Results for *general health interest* do not confirm the third hypothesis (H_3), but they are in

325   line with some recent studies which have noted the strong influence that attitudes towards

326   healthy eating has on the use of claims, as opposed to understanding of these same claims

327   (Cooke & Papadaki, 2014; Grunert et al., 2010).

328   Results for *attitudes towards using food as medicine* are consistent with the forth hypothesis

329   (H_4) and could be translated as the more consumers think that food with health claims could

330   prevent disease, the more consumers are interested in understanding the claim.

331   **Table 7** compares the results obtained with the list of hypotheses for each variable used in the

332   model.

333

334   [INSERT **TABLE 7** HERE]

335

336   **5. Conclusions**

337   The present study aimed to investigate which are the variables that influence the

338   understanding of the four authorized health claims for olive oil, among Italian consumers. The

339   main goal was to explore the possibilities (and current shortcomings) to better differentiate

340   (and exploit) high quality EVOOs on the final market by using health claims.

341   Health claims are considered relevant tools for food industries and their use is fostered by

342   food marketers to promote innovation and competitiveness among food companies (Diaz et

343   al., 2020; Tollin et al., 2016). However, in the public debate about health claims, a common

344   assumption is that consumers do not easily understand the meaning of the claims (Grunert et

345   al., 2010; Miraballes et al., 2014). The problem of comprehension constrains the use of health

346   claims and, consequently, this hinders producers' ability to benefit from the perception of

347   high quality that attaches to products with health claims.

348   In the case of EVOO, an effective implementation of health claims could secure a place

349   within the broader trade category of EVOO for high-quality products that are characterized by

350   the health values that consumers seem to desire. Moreover, the enacting of health claims

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351 system for EVOO was considered by producers as a chance to obtain more benefits derived

352 from higher prices for their products (Tsimdou & Boskou, 2015).

353 The analysis reaffirmed the difficulty Italian consumers experience in the process of

354 comprehending health claims. As shown in previous studies, the use of technical and

355 unfamiliar scientific terms probably leads to confusion among consumers (Ares et al., 2009;

356 Grunert et al., 2011; Singer et al., 2006). Results showed that only 36% of the sample

357 surveyed broadly understood health claims, and just 12% of respondents were able to answer

358 correctly more than 12 of 16 specific questions about the meaning of health claims on EVOO.

359 The low level of consumers' understanding highlighted in this study could represent the main

360 motivation of the failure of the diffusion of health claims on EVOO and, consequently, the

361 impossibility for producers to take advantage from their implementation. Indeed, in the

362 decision-making process before any purchasing, consumers seek information about products

363 and they decide whether to buy or not only after the evaluation and elaboration of this

364 information (J.van buul & Brouns, 2015). Understanding the benefits of health claims is a

365 fundamental step in the purchase process. It has been demonstrated that the more consumers

366 understand the health effect explained in the claim, the more they are intentioned to buy the

367 product with health claim (Diaz et al., 2020). Put differently, the misunderstanding of health

368 claims can influence consumers' evaluation of the quality of products and, consequently, the

369 purchase of them (Kozup et al., 2003; Chandon & Wansink, 2011).

370 Moving on the relationship between consumers' understanding of health claims and socio-

371 demographic/personal variables, the analysis came to light a consumer' profile mostly

372 coherent with similar studies (Cavaliere et al., 2015). To be clearer, elder consumers with a

373 lower perceived health status are more interested in obtaining information regarding

374 nutritional and health properties of food and they are more able to process them (Drichoutis et

375 al., 2005; Lalor, et al., 2011; Siegrist et al., 2008). At the same time, the structure of

376 household with the presence of children is significant related to the consumer' need of

377 seeking information on food labels (Ares et al., 2009; Lalor et al., 2011; Cavaliere et al.,

378 2015). Results highlighted the central role of nutrition knowledge in the process of health

379 claims' understanding. Previous literature has extensively studied the direct and positive

380 relation between nutritional knowledge and health claims understanding (Grunert et al., 2010;

381 Cooke & Papadaki, 2014). The complex method of how consumers try to understand

382 nutritional and health claims, defined by Leathwood and colleagues (2007), as "human

383 information processing" has been demonstrated to be mainly regarded as a question of
384 consumers' knowledge.

385 The most relevant implication from a policy point of view of our research is that, although it
386 is verified that health claims are an effective way to communicate healthiness of food to
387 consumers (Parker, 2003; Caswell et al., 2003; Van Trijp & Var der Lans, 2007), this does not
388 mean that the provision of this information will result in its effective understanding. This gap
389 could be adjusted through an adequate public program of nutritional education and health
390 promotion (Williams, 2005). It is a common concern that health claims could loose their
391 effectiveness without an environment of educational program in support of consumers
392 (Lawrence & Germov, 2004). Therefore, the role of nutrition knowledge should be improved
393 continuously through education programs organised by public and/or regulatory agencies, as
394 well as by food manufacturers and consumers' groups (Cooke & Papadaki, 2014; Cowburn &
395 Stockley, 2005; Nocella & Kennedy, 2012). Indeed, recent nutritional food campaigns have
396 been implemented to improve consumers' familiarity with nutritional information (Mazzocchi
397 et al., 2009; Van Herpen & Van Trijp, 2011). In the specific case of the EVOO market,
398 further efforts are needed to inform consumers about the relation between the healthy
399 properties of EVOO and its content of bioactive compounds (i.e., polyphenols, vitamin E,
400 oleic acid). Public or private campaigns should improve consumers' awareness that the trade
401 category of EVOO comprises different types of products, each differing in terms of their
402 content of bioactive compounds and their health related properties. Finally, marketing
403 managers should also try to conceive of specific marketing strategies and campaigns capable
404 of improving dietary knowledge (Brennan et al., 2008) taking into account socio-demographic
405 and personal characteristics of different consumers (Van Trijp & Var der Lans, 2007).

406 A number of limitations that represent areas for further research should be mentioned. Most
407 importantly, some variables used in the model are based on consumers' self-assessment such
408 as EVOO consumption frequency, EVOO consumption quantity and health condition. On the
409 one hand, these "self-ratings" are often used as indicators of personal situations, on the other
410 hand, they could be biased by motivational factors (Wells & Sweeney, 1986).

411 Secondly, in the research area about food health claims, a deeper understanding of how
412 individuals process information could provide insights on the most efficient way to structure
413 these labels. Furthermore, exploring how consumers make their purchase decisions by

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414 tracking the visual attention paid to areas of interest on labels could shed light on whether and

415 how the presence of health claims increases individuals' attention (Ballco et al., 2019).

416 Therefore, to advance current knowledge, beside the analysis of health claims understanding,

417 it would be useful to evaluate in a real shopping environment the decision making of

418 consumers after the elaboration of label information.

419

423

428

14

APPENDIX A

Olive Oil Health Claims Understanding index.

HC1) Olive oil polyphenols contribute to the protection of blood lipids from oxidative stress.

The claim may be used only for olive oil, containing at least 5 mg of hydroxytyrosol and its

derivatives (e.g. oleuropein complex and tyrosol) per 20 g of olive oil.

In your opinion, the olive oil with this claim provides which health benefits?

(You must mark two correct answers)

1. Facilitates diuresis (F)

2. Helps to prevent the formation of arteriosclerosis plaques (T)

3. Helps to prevent inflammations (T)

4. Helps to reduce body weight (F)

HC2) Replacing saturated fats in the diet with unsaturated fats contributes to the maintenance

of normal blood cholesterol levels. Oleic acid is an unsaturated fat.

In your opinion, the olive oil with this claim provides which health benefits?

(You must mark two correct answers)

1. Helps to maintain good eyesight. (F)

2. Helps to prevent cerebrovascular illness, such as stroke (T)

3. Helps to prevent cardiovascular illness, such as myocardial infarction (T)

4. Helps to prevent ageing (F)

HC3) Vitamin E contributes to the protection of cells from oxidative stress.

In your opinion, the olive oil with this claim provides which health benefits?

(You must mark two correct answers)

1. Reinforces immune system (F)

2. Helps to prevent ageing (T)

3. Contributes to reduce inflammatory processes (T)

4. Helps to preserve intestinal regularity (F)

15

459 HC4) Replacing saturated fats with unsaturated fats in the diet has been shown to

460 lower/reduce blood cholesterol. High cholesterol is a risk factor in the development of

461 coronary heart disease.

462 In your opinion, the olive oil with this claim provides which health benefits?

463 *(You must mark two correct answers)*

464 1. Contributes to reduce the risk of arteriosclerosis (T)

465 2. Helps to keep mind capability (T)

466 3. Helps to keep pulmonary capability (F)

467 4. Improve the resistance to allergy (F)

468

469 **Psychographic characteristics (adapted from Van Trijp & Van der Lans (2007)**

470 *Nutrition importance*

471 7-point scale with end points ranging from never (1) to always (7)

472 1. How often do you select food for reasons of health?

473 2. How often do you eat healthy food?

474

475 *Subjective nutrition knowledge*

476 7-point scale with end points ranging from strongly disagree (1) to strongly agree (7)

477 1. I am knowledgeable about health and nutrition issues.

478 2. My friends ask me for nutritional/health advice or information

479

480 **Nutrition knowledge** (adapted from Parmenter & Wardle, 1999)

481 1) Which fat do experts say is most important for people to cut down on? (tick one)

482 (a) monounsaturated fat

483 (b) polyunsaturated fat

484 (c) saturated fat

485 (d) not sure

486

487 2) Do you think these are high or low in added sugar?

488 (tick one box per food: high; low; not sure)

489 (a) Bananas

490 (b) Unflavoured yoghurt

16

491   (c) Ice-cream

492   (d) Orange squash

493   (e) Tomato ketchup

494   (f) Tinned fruit in natural juice

495

496   3) Do you think these are high or low in salt?

497   (tick one box per food: high; low; not sure)

498   (a) Sausages

499   (b) Pasta

500   (c) Kippers

501   (d) Red meat

502   (e) Frozen vegetables

503   (f) Cheese

504

505   4) Some foods contain a lot of fat but no cholesterol

506   - Agree

507   - Disagree

508   - Not sure

509

510   5) Saturated fats are mainly found in:

511   (tick one)

512   (a) vegetable oils

513   (b) dairy products

514   (c) both (a) and (b)

515   (d) not sure

516

517   6) Harder fats contain more:

518   (tick one)

519   (a) Monounsaturated

520   (b) polyunsaturated

521   (c) saturates

522   (d) not sure

17

523   7) Polyunsaturated fats are mainly found in:

524   (tick one)

525   (a) vegetable oils

526   (b) dairy products

527   (c) both (a) and (b)

528   (d) not sure

529

530   **General health interest** (adapted from Roininen et al., 1999)

531   7-point Likert scale, ranging from strongly disagree (1) to strongly agree (7)

532   1. The healthiness of food has little impact on my food choices (R)

533   2. I am very particular about the healthiness of food I eat.

534   3. I eat what I like and I do not worry much about the healthiness of food.

535   4. It is important for me that my diet is low in fat.

536   5. I always follow a healthy and balanced diet.

537   6. It is important for me that my daily diet contains a lot of vitamins and minerals.

538   7. The healthiness of snacks makes no difference to me (R)

539   8. I do not avoid foods, even if they may raise my cholesterol (R)

540

541   **Attitude towards using food as medicine** (Dean et al., 2012)

542   7-point Likert scale, ranging from strongly disagree (1) to strongly agree (7)

543   1. I can prevent diseases by regularly eating foods with health claims

544   2. Foods with health claims can repair the damage caused by an unhealthy diet

545   3. Foods with health claims make it easier to follow a healthy lifestyle

546   4. Eating foods with health claims will help me to not get some diseases

547

548

549

550

18

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FIGURES

Figure 1 - Distribution of the index for "Understanding of Health Claims" (UHC)
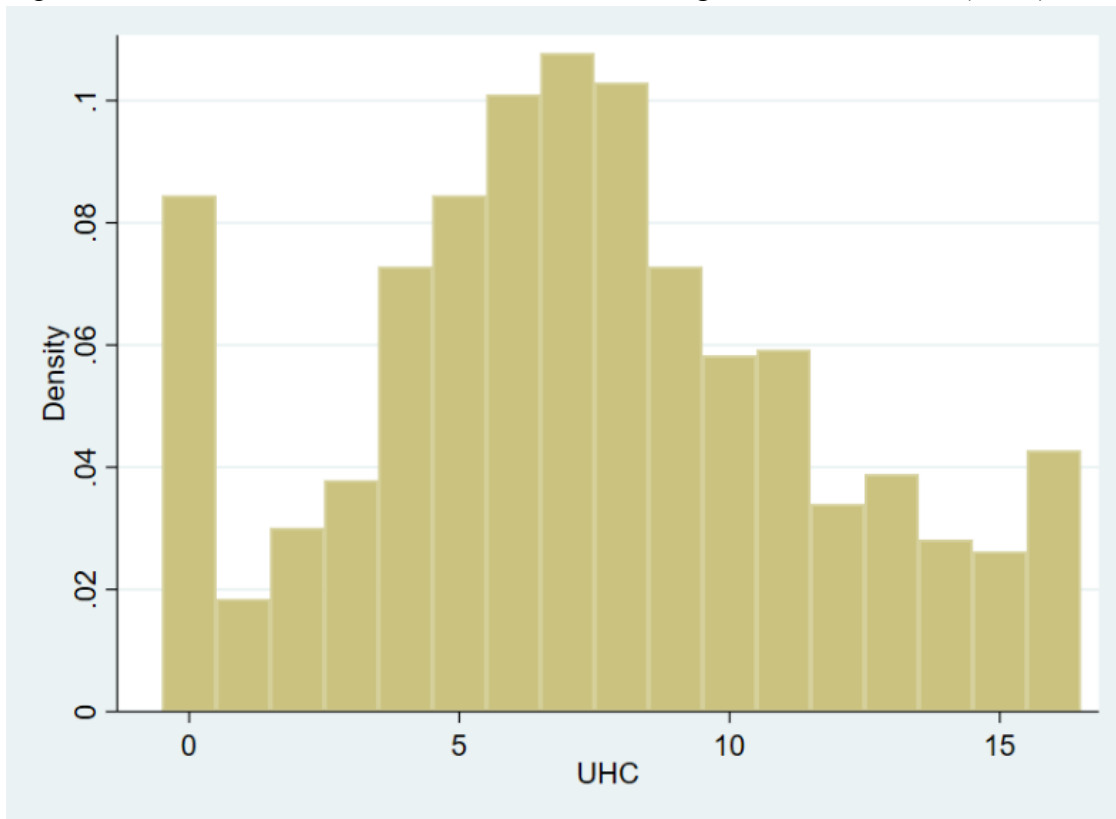
TABLES

Table 1 - List of authorized health claims on olive oil

Claim	Nutrient	Conditions of use	Regulation of approval
i) Olive oil polyphenols contribute to the protection of blood lipids from oxidative stress.[*]	Olive oil polyphenols	The claim may be used only for olive oil which contains at least 5 mg of hydroxytyrosol and its derivatives (e.g. oleuropein complex and tyrosol) per 20 g of olive oil. In order to bear the claim information shall be given to the consumer that the beneficial effect is obtained with a daily intake of 20 g of olive oil.	Commission Regulation (EU) 432/2012 of 16/05/2012
ii) Replacing saturated fats in the diet with unsaturated fats contributes to the maintenance of normal blood cholesterol levels. Oleic acid is an unsaturated fat.[*]	Oleic acid	The claim may be used only for food which is high in unsaturated fatty acids, as referred to in the claim HIGH UNSATURATED FAT as listed in the Annex to Regulation (EC) No 1924/2006.	Commission Regulation (EU) 432/2012 of 16/05/2012
iii) Vitamin E contributes to the protection of cells from oxidative stress.[*]	Vitamin E	The claim may be used only for food which is at least a source of vitamin E as referred to in the claim SOURCE OF [NAME OF VITAMIN/S] AND/OR [NAME OF MINERAL/S] as listed in the Annex to Regulation (EC) No 1924/2006.	Commission Regulation (EU) 432/2012 of 16/05/2012
iv) Replacing saturated fats with unsaturated fats in the diet has been shown to lower/reduce blood cholesterol. High cholesterol is a risk factor in the development of coronary heart disease.[**]	Monounsaturated and/or polyunsaturated fatty acids	The claim may be used only for food which is high in unsaturated fatty acids, as referred to in the claim HIGH UNSATURATED FAT as listed in the Annex to Regulation (EC) No 1924/2006. The claim may only be used on fats and oils	Commission Regulation (EU) No 1226/2014 of 17/11/2014

[*] *Functional claim, approved according to Art.13 (1) of Reg. (EC) 1924/2006*
[**] *Claim for "reduction of disease risk", approved according to Art.14 (1)(a) of Reg. (EC) 1924/2006*
Source: adapted from Roselli et al., 2017

Table 2 - Socio-demographic characteristics of the sample (N = 1,030)

Variable	Sample		Italian population*
	N.	%	%
Gender			
Females	528	51	52
Males	502	49	48
Age range (years)			
18-35	299	29	23
36-45	272	26	17
46-55	247	24	19
> 55	212	21	41
Education			
Primary	108	11	43
Secondary	589	57	41
Tertiary	333	32	16
Children in the household (<12 years)			
Yes	301	29	n.a.
No	729	71	n.a.

*Source: Italian Institute of Statistics – ISTAT (2016)

Table 3 - Personal characteristics of the sample (N = 1,030)

Variable	Sample	
	N.	%
On a special diet		
Yes	136	13
No	894	87
Personal illness		
Yes	200	19
No	830	81
Family member illness		
Yes	338	33
No	692	67
Health condition		
Very bad	7	1
Poor	17	2
Insufficient	43	4
Normal	230	22
Decent	294	28
Good	379	37
Excellent	60	6
EVOO consumption frequency		
More than once a week	899	87
Once a week	80	8
Two or three times a month	37	4
Once a month	14	1
EVOO consumption quantity (per month)		
Half litre or less	219	21
Between half litre and one litre	327	32
Between one litre and two litres	332	32
More than two litres	152	15

Table 4 - Resume of the Olive Oil Health Claims Understanding index

Olive Oil Health Claims Understanding index	Number of respondents	% of the sample
Up to 4	251	24%
Between 5 and 8	408	40%
Between 9 and 12	231	22%
Above 12	140	14%

Table 5 - List of variables included in the estimated model

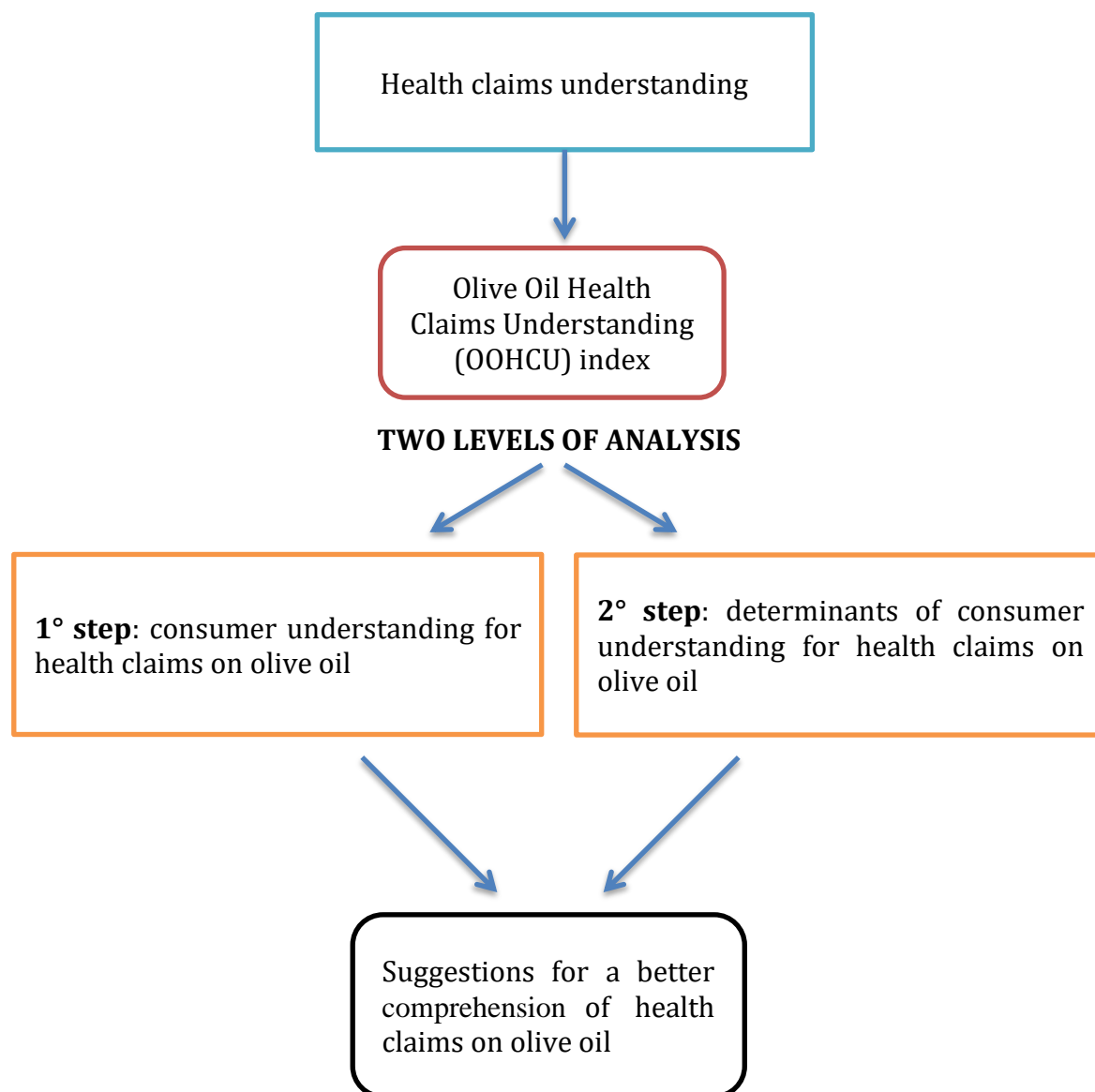| Variables	Type	Range	Mean	Std. Dev.
Gender	Dummy	0 if male, 1 if female	0.51	0.50
Age	Continuous	18 to 70	43.78	12.87
Education	Categorical	1 (=elementary) to 5 (=post-graduate)	3.28	0.73
Children in the household	Dummy	0 if no child, 1 if one or more	0.29	0.45
On a special diet	Dummy	0 if no, 1 if yes	0.13	0.34
Personal illness	Dummy	0 if no, 1 if yes	0.19	0.40
Family member illness	Dummy	0 if no, 1 if yes	0.33	0.47
Health condition	Categorical	1 (=very bad) to 7 (=excellent)	5.10	1.11
EVOO consumption frequency	Categorical	1 (=once a month) to 4 (=more than once a week)	3.81	0.55
EVOO consumption quantity	Categorical	1 (=less than half litre per month) to 14 (=10 litres per month)	5.41	2.12
Nutrition importance	Scale	1 (=never) to 7 (=always)	4.90	1.23
Subjective nutrition knowledge	Scale	1 (=strongly disagree) to 7 (=strongly agree)	4.46	1.51
Nutrition knowledge	Index	0 (=no correct answer) to 17 (=all correct answer)	9.72	3.37
General health interest	Scale	1 (=strongly disagree) to 7 (=strongly agree)	4.84	1.08
Attitude toward using food as medicine	Scale	1 (=strongly disagree) to 7 (=strongly agree)	5.03	1.22

Table 6 - Results of Tobit regression

Variables	Coefficient	Standard Error
Age	0.04***	0.01
Gender	-0.14	0.26
Education	0.23	0.18
Children in the household	0.89***	0.28
On a special diet	-0.56	0.40
Personal illness	0.12	0.36
Family member illness	-0.09	0.28
Health condition	-0.27**	0.12
EVOO consumption frequency	-0.25	0.23
EVOO consumption quantity	0.15**	0.06
Nutrition importance	0.38**	0.38
Subjective nutrition knowledge	0.49***	0.11
Nutrition knowledge	0.52***	0.04
General health interest	-0.10	0.15
Attitude toward using food as medicine	0.73***	0.12

$LL = -2647.3663$
$Pseudo\ R^2 = 0.0701$
$Prob > chi2 = 0.0000$
$* = p<0.1;\ ** = p<0.05;\ *** = p<0.01$

Table 7 - Results of the hypothesis tested

Hypothesis	Accepted	Rejected
H$_1$: the higher are both the scores of "Nutrition importance" and "Subjective nutrition knowledge", the higher will be the understanding of health claims	X	
H$_2$: the higher the "Nutrition knowledge" index, the higher will be the understanding of health claims	X	
H$_3$: the higher the "General health interest" score, the higher will be the understanding of health claims		X
H$_4$: the higher the "Attitude towards using food as medicine" score, the higher will be the understanding of health claims	X	

Health claims understanding

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Olive Oil Health
Claims Understanding
(OOHCU) index

TWO LEVELS OF ANALYSIS

1° step: consumer understanding for health claims on olive oil

2° step: determinants of consumer understanding for health claims on olive oil

Suggestions for a better comprehension of health claims on olive oil

CRediT author statement

Alessia Lombardi: Conceptualization**,** Data Curation, Writing - Original Draft, Writing - Review & Editing. **Domenico Carlucci:** Validation, Visualization, Writing - Review & Editing. **Carla Cavallo**: Conceptualization, Data Curation, Writing - Review & Editing. **Bernardo De Gennaro**: Conceptualization, Validation, Supervision, Project administration, Funding acquisition. **Teresa Del Giudice**: Conceptualization, Validation, Writing – Review & Editing, Visualization. **Giacomo Giannoccaro**: Validation, Visualization, Writing - Review & Editing. **Antonio Paparella:** Formal analysis, Methodology, Data Curation. **Luigi Roselli:** Conceptualization**,** Validation, Writing - Original Draft, Writing - Review & Editing, Visualization. **Riccardo Vecchio:** Conceptualization, Methodology, Writing – Review & Editing. **Gianni Cicia:** Conceptualization, Validation, Writing – Review & Editing, Visualization, Supervision.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Alessia Lombardi

Domenico Carlucci

Carla Cavallo

Bernardo De Gennaro

Teresa Del Giudice

Giacomo Giannoccaro

Antonio Paparella

Luigi Roselli

Riccardo Vecchio

Gianni Cicia