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Why people follow a gluten-free diet? An application of health behaviour models

Abstract

Purpose: To understand factors affecting adherence to GFD by celiac and non-celiac people through the application of behavioural theories, Integrative Model (IM) and Multi Theory Model (MTM).

Methods: Analyses were conducted for a sample of 308 subjects, majority females, celiac and non-celiac. Adherence to GFD was measured considering two scales, self-declared adherence and scored adherence, in order to discern possible inconsistencies between what subjects believe and what they really do. Subsequently, adherence to GFD was modelled by considering constructs of MTM and IM. Moreover, the constructs were designed based on literature review. Ordered logit (OL) model was used to test the IM and MTM theoretical models.

Results: The findings show that adherence to GFD is affected mainly by attitudes towards GFD, self-efficacy, injunctive norms, knowledge about GFD and perceptions that GF products are expensive. Between the two models, IM and MTM, results show that all constructs of IM explain the behavior. Contrary, for MTM, results indicate only some constructs of the MTM explain adherence to GFD.

Conclusions: Results of this study should be considered for improving the adherence to GFD for celiac people. Furthermore, it is important to consider the non-celiac people's perceptions for GFD and GF products. In other words an accurate information about the diet and products it is relevant for supporting people to make healthier food choices. Finally, as the results show, IM explain adherence to GFD better than MTM.

Why people follow a gluten-free diet?

An application of health behaviour models

1. Introduction

A gluten-free diet (GFD) excludes the protein gluten, which is found mainly in wheat, rye and barley. To date, GFD is the only treatment for people affected by celiac disease (CD), an autoimmune disorder of the small intestine caused by the ingestion of gluten (A. Lerner, 2010; Trier, 1998). Within the first weeks of GFD's adoption, patients diagnosed with CD declared improvements in the symptoms of the disease (Sadeghi et al., 2020). Therefore, following GFD is crucial for the well-being of people affected by the CD. Thus, the first main issue this study investigates is how to improve adherence to GFD by celiac people.

However, apart from celiac patients, in recent years, non-celiac consumers are also embracing the GFD. To illustrate, according to the Nielsen report on healthy eating, 23% of the participants in the survey avoided gluten (Nielsen, 2015). Moreover, in Italy, approximately 6 million people follow a GFD voluntarily (Associazione Italiana Celiachia, 2017). However, why do non-celiac people follow the diet? Firstly, family members of celiac people are following a GFD to avoid food contamination at home. Since the predisposition to the disease is considered inherited, the GFD might prevent the appearance of it to other members (Bogue & Sorenson, 2008). Secondly, GFD has been recognised as a treatment option for other conditions, like dermatitis herpetiformis, anaemia, irritable bowel syndrome, rheumatoid arthritis, diabetes mellitus, HIV-associated enteropathy, autism and other neurologic disorders (Bürk et al., 2009; El-Chammas & Danner, 2011; Srihari Mahadev et al., 2013; Samasca et al., 2017). Finally, other people who do not have any specific symptoms have recently been following the diet, mainly influenced by non-celiac celebrities who state that GFD helps to lose weight and boosts the energy (Ranker, 2015). Hence, the second topic in which this research focuses on is to discern factors that drive non-celiac people to follow the diet and the ways to support them in making healthy food choices. This aspect is of high importance since, to date, research has failed to show that GFD is a better diet option for the non-celiac general population (Gaesser & Angadi, 2012; B. A. Lerner, Green, & Lebwohl, 2019; Marcason, 2011; Niland & Cash, 2018). In line with this, D. Lis, Stellingwerff, Kitic, Ahuja, & Fell (2015) did not find any effect of the GFD on the overall performance of non-celiac athletes.

Hence, while following GFD is strongly related to the well-being of the people suffering from CD, the reasons why non-celiac people follow a GFD remain unclear. Why are people ready to pay higher prices and engage in a diet which has not been scientifically proven to be healthier than other options? In what ways is it possible to improve adherence to GFD by celiac and other people who follow the diet for health reasons?

This study uses health behaviour models, for distinguishing factors that affect adherence to GFD among celiac and non-celiac people, and to respond to the above questions: the Integrative Model (IM) and the Multi Theory Model (MTM). This research is relevant for the field since, to date, a limited number of studies have applied behavioural models aiming to understand and improve adherence to GFD by celiac patients, and no previous studies have considered non-celiac-people. Protection Motivation Theory (PMT) and Theory of Planned Behaviour (TPB) have been used to understand adherence to GFD. The PMT identifies the way people engage in a given behaviour due to fear appeal, which, according to the theory, is composed by three components (a) the magnitude

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62 of noxiousness of a depicted event; (b) the probability of that event's occurrence; and (c) the efficacy
63 of a protective response (Rogers, 1975). The TPB, on the other hand, is based on the Theory of
64 Reasoned Action (TRA) and states that individuals, based on the given information, make rational
65 and target-directed decisions (Ajzen, 1991).
66

67
68 As previously mentioned, both theories have been considered to identify factors affecting adherence
69 to GFD from part of celiac patients. Dowd, Jung, Chen, & Beauchamp, (2015) applied the PMT in
70 their study and found that self-regulatory efficacy indirectly predicted purposeful instances of gluten
71 consumption through intentions and directly predicted accidental gluten consumption. However, the
72 authors of this study did not consider social norms. Moreover, Sainsbury & Mullan (2011); Sainsbury,
73 Mullan, & Sharpe, (2013) and (2015) have applied the TPB to understand adherence to GFD by celiac
74 patients. They found that TPB is good at predicting adherence to GFD.
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76
77 Nevertheless, the theories mentioned above present some limitation. Firstly, the PMT does not
78 consider other environmental factors and cognitive variables that might affect the behaviour of an
79 individual to engage or not in a behaviour (Rogers, 1975). Secondly, Dowd et al., (2015) did not
80 consider social norms in their model, but, in the recent years, studies are considering to use social
81 norms as tools for changing people's health-related behaviour (Mollen, Rimal, & Lapinski, 2010). In
82 addition to this, scholars are suggesting that there are two groups of social norms: beliefs about what
83 others do (*descriptive norms*) and beliefs about what others think an individual should do (*injunctive*
84 *norms*) (Cialdini et al., 2006; Cialdini, Reno, & Kallgren, 1990; Cislighi & Heise, 2019). Thirdly,
85 theories based on TRA and TPB are too rational and do not consider some irrational sides of the
86 human behaviour, such as compulsive behaviour and/or emotions (Armitage, Conner, & Norman,
87 1999).
88

89
90 However, the IM, based on the TRA and developed by Fishbein in 2008, has overcome the limitations
91 listed above. Nevertheless, according to Fishbein (2008), TRA-based theories are not too rational
92 since they also consider the irrational side of the behaviour such as background factors. Thus, IM
93 states that intentions to exert a particular behaviour do not always predict the behaviour itself, and
94 sometimes people do not act according to their intention. As figure 1 shows, it might happen that
95 even though an individual has a positive intention towards a given behaviour, he/she does not perform
96 the behaviour because he/she does not have the necessary skills and abilities or internal/external
97 barriers prevent him/her from doing it (Fishbein, 2008). Moreover, in line with the recommendations
98 of scholars, IM considers subjective norms as a function of descriptive and injunctive norms.
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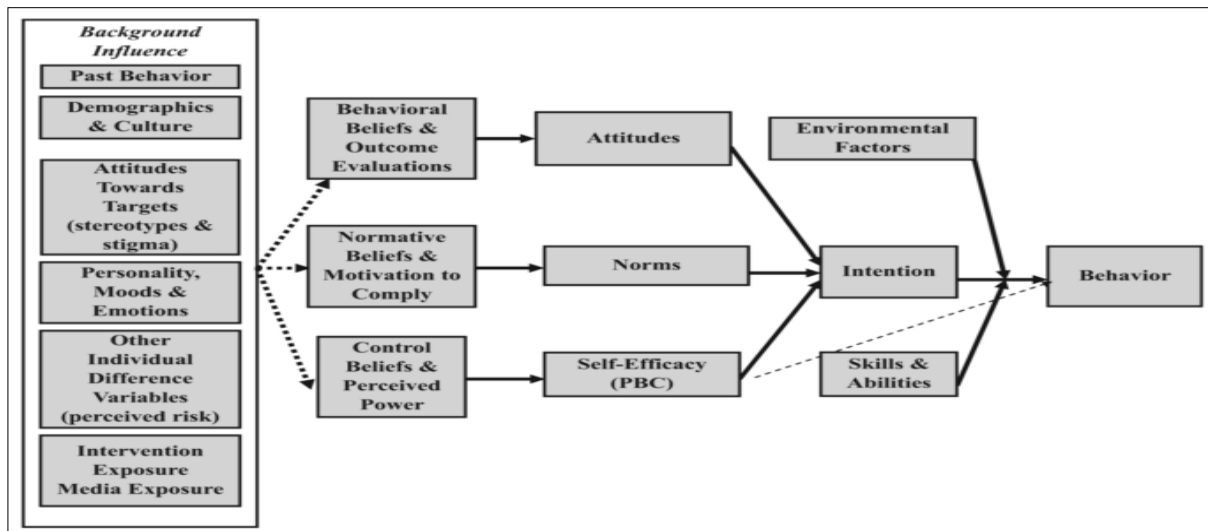


Figure 1 Integrative Model (Fishbein 2008)

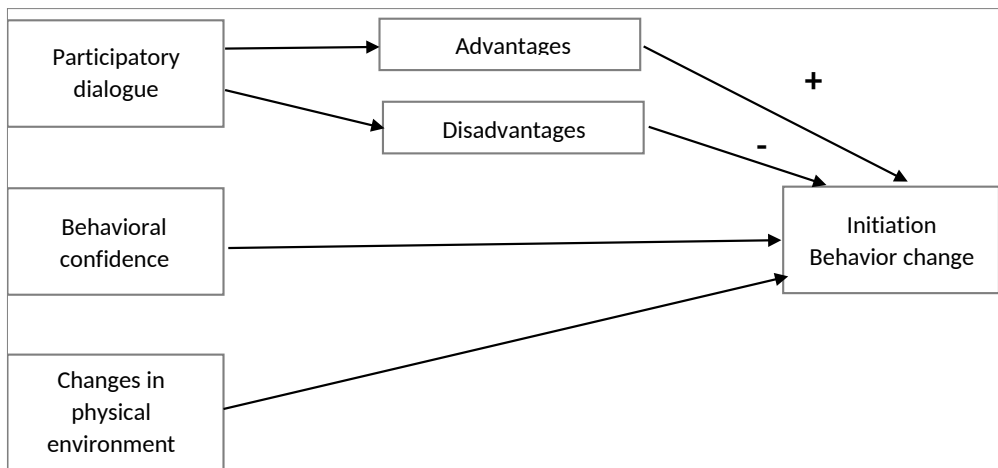


Figure 2 Initiation Model, MTM (Sharma 2015)

Another new theory is the multi-theory model (MTM) of health behaviour change developed as a collective intelligence exercise guided by Sharma in 2015. The model is also based on the TRA and puts together empirically tested constructs from previous theories. However, MTM states that it has overcome some limitations of the previous theories as it firstly, considers one-time and long-term behavioural changes; secondly, it is applicable in an individual, group and community level, and thirdly, it is culturally viable (Manoj Sharma, 2015). The model considers behaviour as a function of two phases, first the initiation of the behaviour change (figure 2) and second, the continuation of the change (figure 3).

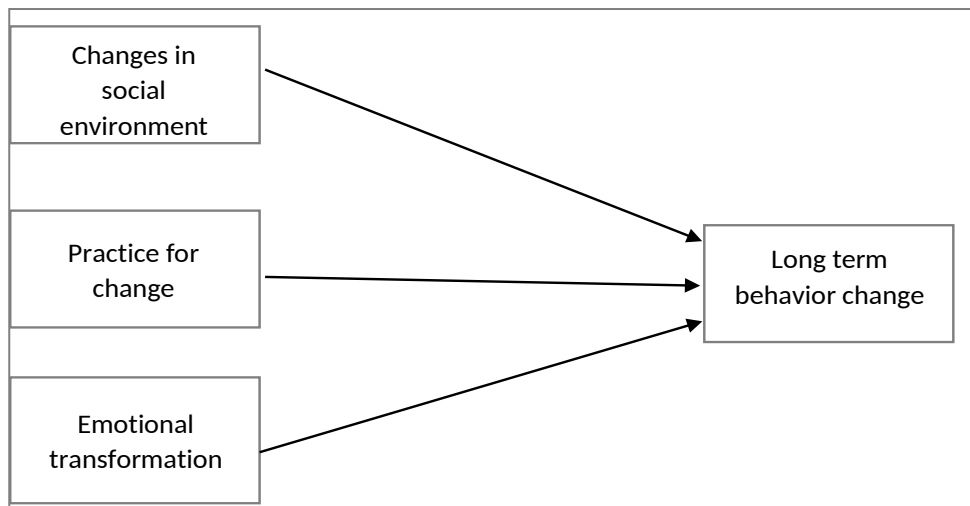


Figure 3 Continuation Model, MTM (Sharma 2015)

Understanding behaviour towards GFD is of high importance firstly, for celiac patients, since GFD is the only treatment for CD; secondly, for non-celiac consumers who voluntarily follow the diet, since to date no research has found that GFD is a healthier option for them; thirdly, it is important to understand the drivers, which can increase the level of intention to start following the GFD from part of people who do not follow the diet yet and who do not suffer from any specific health condition related to CD. Therefore, the main objective of this study is to understand factors mostly affecting adherence to the GFD from both, celiac and non-celiac people, followers and non-followers of the diet, by considering health behaviour models, IM and MTM.

Moreover, while IM has largely been applied to other research mainly on sexual behaviour (Buhi et al., 2014) and sleeping issues (Robbins & Niederdeppe, 2015; Tagler, Stanko, & Forbey, 2017), it has been applied to only one food consumption study (Collado-Rivera, Branscum, Larson, & Gao, 2018). According to Collado-Rivera et al. (2018), IM is a useful model for explaining sugary drink consumption among overweight and obese adults. Therefore, testing this model is of high interest for researchers.

On the other hand, MTM has been mostly applied for explaining behaviour related to physical activity (Bridges & Sharma, 2017; Manoj Sharma et al., 2016) and smoking (M Sharma, Khubchandani, & Nahar, 2017; Manoj Sharma, 2017). Two studies apply the MTM to predict and explain the health behaviour related to food (Manoj Sharma et al., 2017, 2016). They suggest that MTM is a useful tool in explaining and predicting behaviour. However, since it is a new method, it is necessary to broaden the range of behaviours investigated and the sample, which currently is limited to university students and children.

2. Methods

2.1. Data collection

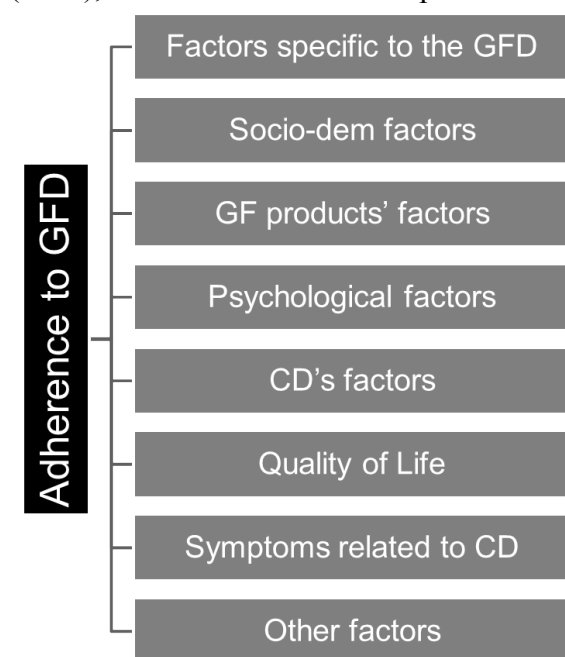
The study was conducted in Italy from May to June 2018, with celiac and non-celiac participants, followers and non-followers of the GFD. The survey was designed and administered using the online survey service Qualtrics. Participants were recruited through social media (Facebook groups dedicated to CD and GF products), events dedicated to CD, and through visits to supermarkets and specialised stores where leaflets were given to participants with the link of the survey. Since some of the questions covered aspects of psychological and health status, and quality of life (QOL), participants self-administered the questionnaire to reduce the possible biases in case it was administered by the researcher.

Participation was voluntary, and subjects were informed from the beginning that they were not going to receive incentives for participating in the study.

2.2. Model constructs and hypothesis generation

Small modifications to the original versions were deemed necessary for both models, to adapt them to the objectives and the context of this study.

Firstly, since participants' background was complex, some belonging to the celiac group, some others were non-celiac following GFD and others were not celiac and were not following the GFD, the authors, considering the core of IM and MTM, made some adjustments in the application of the models to the participants. Thus, IM was applied to all the participants of the study. Secondly, MTM's initiation behaviour change model describes the process of moving from one behaviour (not following the GFD) to another (starting the GFD), thus, the authors considered to apply this model only to the people who are not following the GFD. On the other hand, MTM's continuation of the behaviour model describes the process of performing the behaviour over a period of time (continue to follow GFD). Hence, it was applied to participants who already follow the diet. According to Manoj Sharma (2015), this differentiation is important because the constructs that affect the initiation of change are



different from the constructs that influence the behaviour change. Moreover, since the initiation model does not measure the actual behaviour but an intention to engage in the behaviour, the dependent variable for this model was the intention to start following the GFD and the actual behaviour, adherence to GFD that served as the dependent variable for the continuation model.

Regarding the constructs for the theoretical models, IM and MTM, authors relied on the results from reviews on the adherence to GFD. To date, there are three systematic reviews, which have identified factors affecting adherence to GFD. (Hall, Rubin, & Charnock (2009) found that origins, age of diagnosis, emotional and socio-cultural influences, membership of an advocacy group and regular dietetic follow-up are the factors explaining adherence to GFD mostly. However, Hall et al

Figure 4 Factors affecting adherence to GFD (Xhakollari et al 2019)

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298 (2009) did not consider aspects of GF products, and their search was limited only to celiac patients.
299 More recently, another systematic review aimed at understanding the relationship between depressive
300 symptoms and adherence to GFD (Sainsbury & Marques, 2018). They found that higher levels of
301 depression are associated with lower adherence to GFD, but the authors suggest to carefully consider
302 these findings because the number of studies meeting the inclusion criteria is limited (Sainsbury &
303 Marques, 2018).
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306 Nevertheless, both studies focus on celiac patients and have considered only a few factors affecting
307 adherence to GFD. In addition to this, Xhakollari, Canavari, & Osman (2019) conducted a review
308 considering not only celiac patients but also other people who for reasons other than CD follow the
309 GFD. Results of this review show that adherence to GFD is affected by eight factors (figure 4).
310

311 Thus far, an explanation of the necessary changes of IM and MTM and possible factors affecting
312 GFD was introduced. The following paragraphs will explain the hypotheses which this research is
313 putting forward and will introduce, in a schematic way, the models applied to this study.
314

315 Going back to IM, attitudes are considered as important for explaining the behaviour. Therefore, the
316 study proposes the following hypothesis:
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318 *Hypothesis 1: Attitudes towards the GFD affect adherence to GFD*

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320 Normative beliefs or perceived norms (social pressure) is another necessary construct to consider
321 when understanding the behaviour towards health. According to IM, the social pressure of an
322 individual to perform a particular behaviour is influenced by beliefs of other significant people in
323 their life, or by what other people do (descriptive norms), and by what other people think an individual
324 should do in relation to performing or not the behaviour (injunctive norms) (Fishbein, 2008). Hence,
325 the study proposes the following hypotheses:
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327 *Hypothesis 2a: Strong injunctive norms improve adherence to GFD*

328 *Hypothesis 2b: Strong descriptive norms improve adherence to GFD*

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330 However, in MTM, this construct does not appear. The model suggests that the support given by
331 others is more important for performing and maintaining the behaviour (following GFD) than what
332 others do and/or believe (Manoj Sharma, 2015). According to Xhakollari et al (2019), changes in the
333 social environment are related to constructs of QOL, which include the degree of satisfaction with
334 the support from family members and friends, and the support given by medical services. Thus, the
335 hypothesis, in this case, is:
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338 *Hypothesis 3: Participants receiving high support by others have higher adherence to GFD*

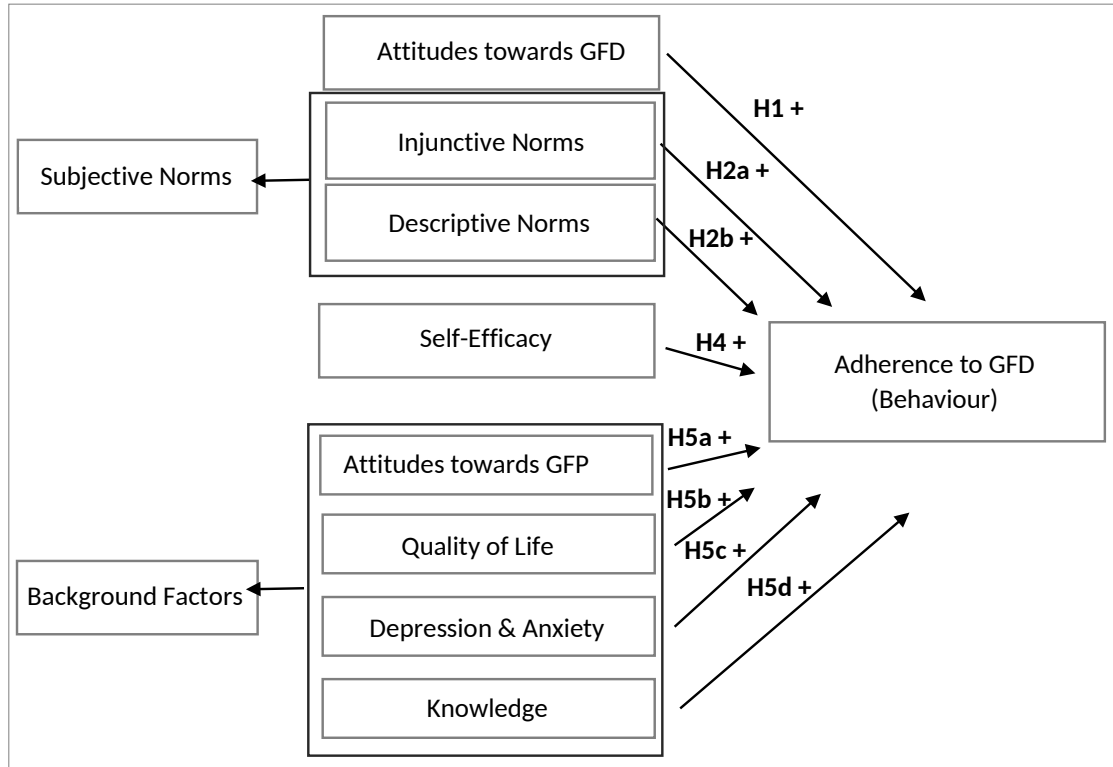
339
340 Self-efficacy is one's belief to succeed in a given situation or to achieve a specific behaviour (Bandura,
341 1982). Both IM and MTM, consider this factor as very important for performing and maintaining the
342 behaviour (adherence to GFD), thus the hypothesis is:
343

344 *Hypothesis 4: Participants with high self-efficacy have higher adherence to GFD*

345
346 In their articles about the theoretical explanation of IM and MTM, Fishbein (2008) and Manoj Sharma
347 (2015) do not provide a detailed explanation of the environmental factors affecting the behaviour.
348 The authors, after careful consideration of the results of the reviews, have acknowledged the
349 possibility that attitudes towards GF products, QOL, Depression and Anxiety and Knowledge affect
350 adherence to GFD and the continuation to follow the diet. Thus the hypotheses are:
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357 *Hypothesis 5a: Perceptions about GF products affect adherence to GFD.*
358 *Hypothesis 5b: Participants with high levels of QOL have a higher level of adherence to GFD.*
359 *Hypothesis 5c: People with high levels of depression and anxiety do not follow a strict GFD.*
360 *Hypothesis 5d: Good knowledge positively affects adherence to GFD.*
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363 Figure 5 and figure 6 presents, respectively, the IM and MTM continuation model applied to the
364 present study.
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Figure 5 Adherence towards GFD explained by the Integrative Model

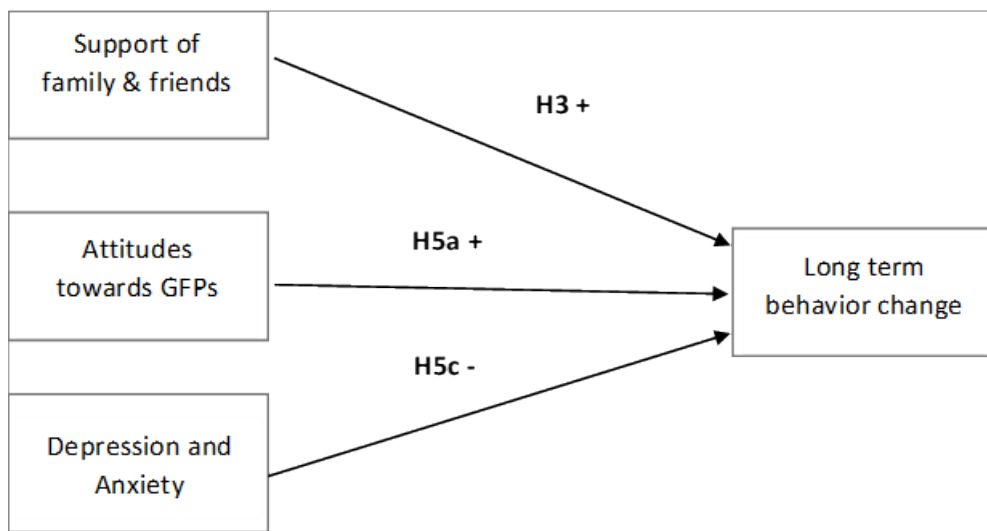


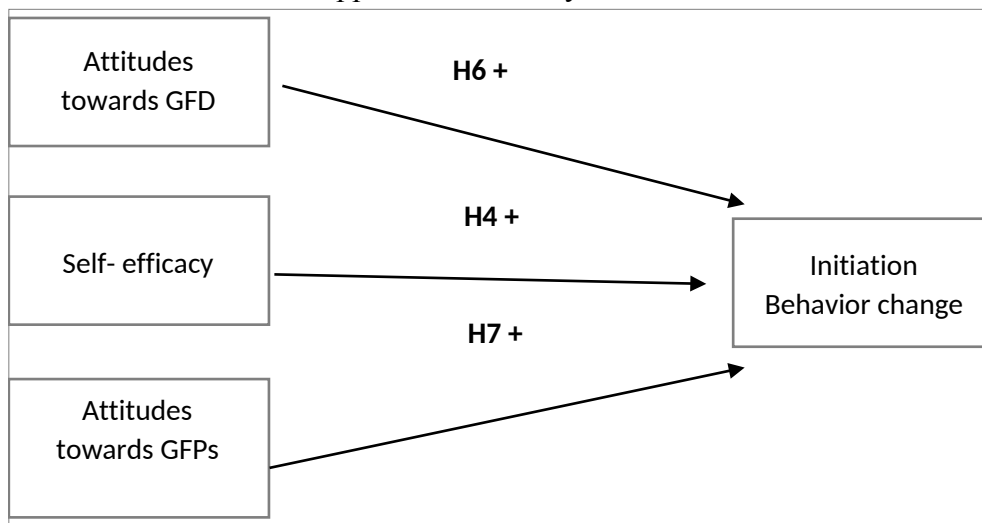
Figure 6 Continuation of the GFD explained by the Multi Theory Model

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416 Regarding the "initiation model", changes in the physical environment have been considered as
417 important when predicting the behaviour. In this case, after considering results from Xhakollari et al.,
418 (2019), attitudes towards GF products have been the changes in the physical environment construct
419 of the theoretical model. Hence, the study put forward the following hypothesis:
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421
422 *Hypothesis 6: For non-followers of GFD, attitudes towards GFD are important when predicting the*
423 *intention to initiate a GFD.*

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425 *Hypothesis 7: For non-followers of GFD, attitudes towards GF products will increase the*
426 *possibility to follow GFD.*

427 Figure 7 shows the initiation model applied to this study.



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Figure 7 Intention to initiate the GFD explained by the Multi Theory Model

2.3. Study design

448 The survey was designed by considering mainly constructs of the IM and MTM. At first, participants
449 were asked to give consent on the usage of their data and were assured that all the information they
450 would provide saved their anonymity. The research design and the questionnaire were approved by
451 the Bioethics Committee of the University of Bologna.

452
453 At first, screening questions were included, and participants were asked to answer with "Yes" or "No"
454 if they knew CD, gluten and GF products. Moreover, since the study was addressed to adults,
455 participants were asked if they were 18 years or older. In case participants were answering "No" to
456 one of these questions, they were not allowed to continue with the questionnaire.

457
458 The second part of the survey consisted of questions related to the GFD. Firstly, participants were
459 asked to self-declare adherence to GFD. The scale items were developed by the authors and were: I
460 eat only gluten-free products; I try to avoid gluten; I try to balance the consumption of gluten and
461 gluten-free products; I don't mind the presence of gluten in the food I consume. Afterwards,
462 participants that declared to follow GFD were asked a set of questions, developed by Biagi et al.
463 (2009), to evaluate the level of adherence to the GFD, which we will call scored adherence to GFD.
464 This question was not applied to individuals who responded "I don't mind the presence of gluten in
465 the food I consume" to the scale developed by the authors. According to Biagi et al. (2009), from a
466 clinical point of view, the scored adherence can be divided into three groups: 0-1 point, subjects do
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475 not follow a strict GFD; 2 points, subjects are following GFD, but with mistakes; and 3-4 points,
476 subjects are following a strict GFD.
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479 The third part consisted of questions regarding attitudes towards GFD. Participants were asked to
480 evaluate on a Likert-like scale ranging from 1 (Strongly disagree) to 5 (Strongly agree) a set of
481 statements retrieved from existing literature (De-Magistris, Xhakollari, & De Los Rios, 2015; de
482 Magistris, Xhakollari, & Munoz, 2015; Edwards George et al., 2009; D. M. Lis, Stellingwerff, Shing,
483 Ahuja, & Fell, 2015; Sainsbury & Mullan, 2011; Shah et al., 2014; Ukkola et al., 2012a; Villafuerte-
484 Galvez et al., 2015; Xhakollari & Canavari, 2019).
485

486
487 The same Likert scale was applied for the fourth part of the questionnaire, which measured subjective
488 norms, self-efficacy and intention to start a GFD. Considering recommendation from scholars
489 explained in the section of methods, subjective norms were measured by distinguishing between
490 injunctive norms: "*My family (parents / brothers / sisters / partners / children) consider that I should*
491 *follow a gluten-free diet*"; "*My friends and colleagues consider that I should follow a gluten-free*
492 *diet*"; and descriptive norms: "*In my family (parents / brothers / sisters / partners / children) there*
493 *are people who follow a gluten-free diet*"; "*In my circle of friends and / or colleagues there are people*
494 *who follow a gluten-free diet*". Regarding self-efficacy, authors measured it by distinguishing
495 between followers and non-followers of the diet. Thus, followers were asked to express their level of
496 agreement with the statement: "*I am sure I manage the gluten-free diet very well*"; and non-followers
497 of the diet responded to the statement: "*If I was a celiac, I am sure I would be able to manage the*
498 *gluten-free diet very well*". Finally, regarding the intention to start a GFD, non-followers of the diet
499 were asked about their level of agreement with the statement: "*It is very likely that I will try to start*
500 *a gluten-free diet for my personal choice*".
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505 The fifth part of the survey presented questions on the diseases and symptoms related to CD and other
506 food allergies that participants could suffer from. This question aimed to split the sample between
507 celiac and non-celiac people and also to understand better the background of the participants.
508

509
510 The sixth part consisted of questions related to GF products. Firstly, participants were asked to
511 evaluate on a Likert-like scale from 1 (Strongly disagree) to 5 (Strongly agree) the level of agreement
512 with four statements regarding GF products: "*Gluten-free products cost more compared to*
513 *conventional products*"; "*I think that a person should follow the gluten-free diet only if it was*
514 *recommended to him by the doctor*"; "*Gluten-free products are less tasty than conventional*";
515 "*Gluten-free products are difficult to find in stores*". The second question of this part was about the
516 knowledge of GF products. Participants were asked to evaluate from a given list of products if they
517 were GF, potentially containing gluten, and containing gluten. The scale was developed considering
518 Silvester et al. (2016), but some items were chosen from the web site of the Italian Celiac Association,
519 to adjust products to the Italian market (Associazione Italiana Celiachia, 2001).
520

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522 The seventh part of the questionnaire evaluated the level of Depression and Anxiety. The scale was
523 adopted from Lovibond & Lovibond (1995). However, considering the length of the questionnaire,
524 we reduced the items to six, selecting those items with the highest factor loadings, three items for
525 Depression: "*I felt that life was meaningless*"; "*I felt I was pretty worthless*"; "*I felt that I had nothing*
526 *to look forward to*"; and three items for Anxiety: "*I was aware of the action of my heart in the*
527 *absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)*"; "*I experienced*
528 *trembling (e.g., in the hands)*"; "*I felt I was close to panic*".
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531

The eighth part of the survey of this study focuses on quality of life, which used the scale developed by Burckhardt & Anderson (2003) since it is a consolidated scale for measuring QOL and has been applied to other studies on GFD. Subjects were asked to estimate on a nine-level scale the way they felt about different aspects of their life. However, an item on the medical support was added since many studies have shown that it affects adherence to GFD (Ferster, Obuchowicz, Jarecka, Pietrzak, & Karczewska, 2015; Muhammad, Reeves, Ishaq, Mayberry, & Jeanes, 2017; J. A. Silvester et al., 2016).

Finally, to evaluate the profile of the participants, the last part of the questionnaire consisted of questions on the socio-demographic characteristics of the sample.

2.4. Data analysis

Data were analysed using R Core Team (2013) 3.5.1. Firstly, descriptive statistics allowed to understand the general profile of the participants. Secondly, correlation tests were applied to understand if the constructs of the model were associated with each other. An Ordered logit (OL) model was used to test the IM and MTM theoretical models using the survey data. The OL statistical model was chosen because of the type of dependent variable (adherence to GFD) that is measured using an ordinal scale, and the kind of relationship between dependent and independent variables.

3. Results

A total of 308 respondents completed the survey. Most of the subjects were recruited through social media (54.5%) and activities about CD and face to face (44.8%). The selected demographic attributes are shown in Table 1. The majority of participants were female (80.19%), and the average age of respondents was 39 years old. This sample profile is in line with the fact that CD mostly affects females (Singh et al., 2018) and that females are more concerned about food (Charlton et al., 2014; Dean, Lähteenmäki, & Shepherd, 2011) and their body shape (Mooney, DeTore, & Malloy, 1994). Most of the respondents have a University Degree (49.03%) or a high school diploma (35.39%), and none had elementary education level.

Table 1 Socio-demographic characteristics of the participants

Characteristics	Share of Total (%)
<i>Gender</i>	
Female	80.19%
Male	19.81%
<i>Age (Median)</i>	<i>39 years old</i>
18-30	26.62%
31-50	52.27%
51-60	16.23%
Older than 60	4.88%
<i>Education level (Modal categ.)</i>	<i>University degree</i>
Less than middle school	0%
Middle school	4.87%
High school or equal	35.39%
University degree	49.03%
Other	9.74%
Prefer not to say	0.97%

<i>Background with CD (Modal categ.)</i>	<i>Non-celiac</i>
Celiac	35.01%
Having a family member with CD	11.69%
Non-Celiac	46.75%
<i>Self-declared adherence (Modal categ.)</i>	<i>I eat only GF products</i>
I don't mind the presence of gluten	35.4%
I try to balance	11.04%
I try to avoid gluten	8.44%
I eat only GF products	45.13%
<i>Scored adherence (Median)</i>	<i>0-1 points</i>
0-1 points	67.53%
2 points	0.97%
3-4 points	31.49%

As described in the methodology section, adherence was measured by considering the scale used by Biagi et al. (2009) and another scale designed by the authors, to evaluate if there is any consistency between what participants declared (authors' scale) and their scored adherence (Biagi's scale).

Table 2 shows that 13.31% of the subjects who declared to follow a strict GFD scored 0-1 points, suggesting that what they self-declared did not consist with what they really do. This finding is very important, especially for individuals who follow GFD because of health problems.

Table 2 Cross data on self-declared and scored adherence to GFD

		Scored adherence		
		0-1	2	3-4
Declared adherence	I don't mind the presence of gluten	35.39%	0%	0%
	I try to balance	10.39%	0.65%	0%
	I try to avoid gluten	8.44%	0%	0%
	I eat only GF products	13.31%	0.32%	31.49%

Considering the results from both scales, a new variable that represents GFD adherence from all the subjects of the study was created. The new adherence variable classifies the respondent's adherence to GFD using three levels, where 1= do not follow a GFD (includes all those who responded "I don't mind the presence of gluten"), 3= follow a strict GFD (includes and those who responded "I eat only GF products" and scored 3-4), and 2= follow the GFD with mistakes (includes all those who are in between) (Tables 3).

Table 3 Participants' adherence to GFD

	Adherence to GFD		
	Do not follow GFD	Follow GFD with mistakes	Follow strict GFD
Percentage of subjects	35.39%	33.12%	31.49%

3.1. Results on IM and MTM explaining adherence to GFD

Results on IM are shown in Table 4 and the verification of the hypotheses in Figure 8. The factors affecting adherence to GFD are related to attitudes towards GFD, injunctive norms, self-efficacy and background factors, such as knowledge and attitudes towards GF products.

Table 4 Results on IM

		Dependent variable:
		Adherence to GFD
Attitudes towards GFD	GFD reduces symptoms of CD	0.215**
	People who follow a GFD have a healthier diet	0.246**
	GFD helps to lose weight	-0.244**
	A person should follow GFD only if prescribed by a health professional	0.278**
Injunctive norms	My family and friends think I should follow GFD	1.085***
Self - efficacy	I manage/I would manage very good the GFD	0.351***
Backg round factor	Knowledge	0.165***
	“GFP products are more expensive than conventional	0.405*
Observations		308

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

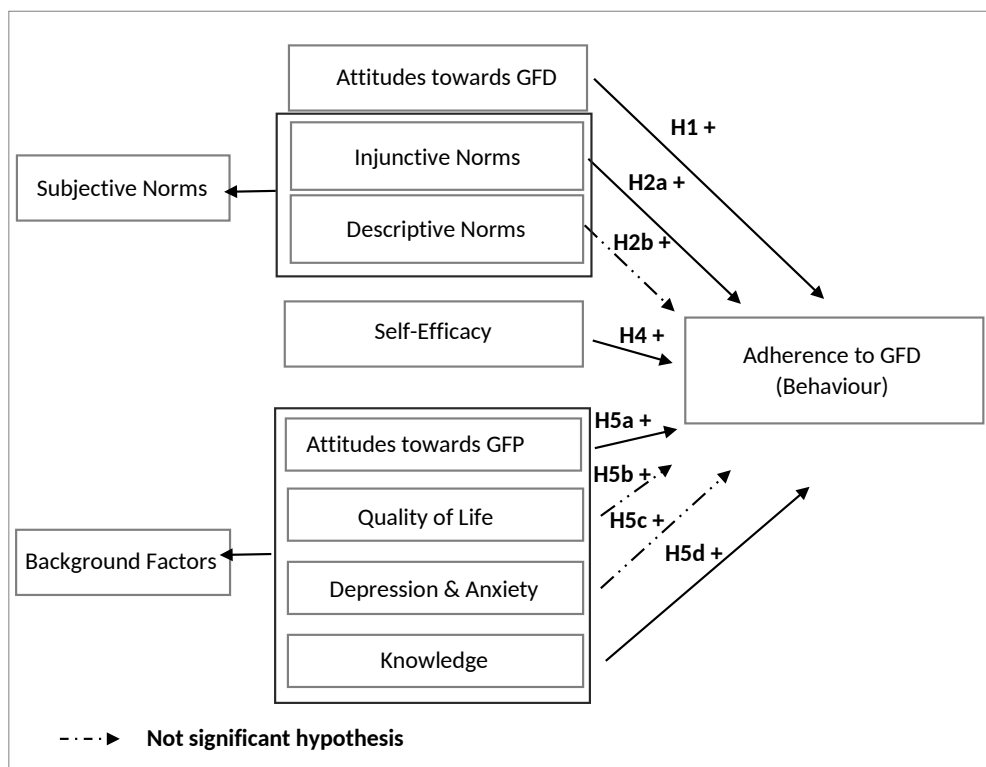


Figure 8 Results of IM about adherence to GFD

Concerning the initiation of the GFD, we applied it only to non-followers of the diet. In this case, the dependent variable was not the adherence to GFD but intentions of subjects to start following the GFD, measured on a 5 point scale. Results are shown in table 5 and figure 9. As it is observed, people

who think that following a GFD helps to maintain a healthier diet and helps one to be more physically active tend to agree with the fact that they might start following a GFD. Thus, considering the hypotheses for the initiation model and these results, we confirm only hypothesis 6. Hence, beliefs play an important role in non-celiac people who think to follow a GFD.

Table 5 Results on MTM (initiation model)

Dependent variable:	
Intention to start following GFD	
People who follow a GFD have a healthier diet	0.449**
People who follow GFD are more active compared to the ones that don't	0.614***
Observations	109

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

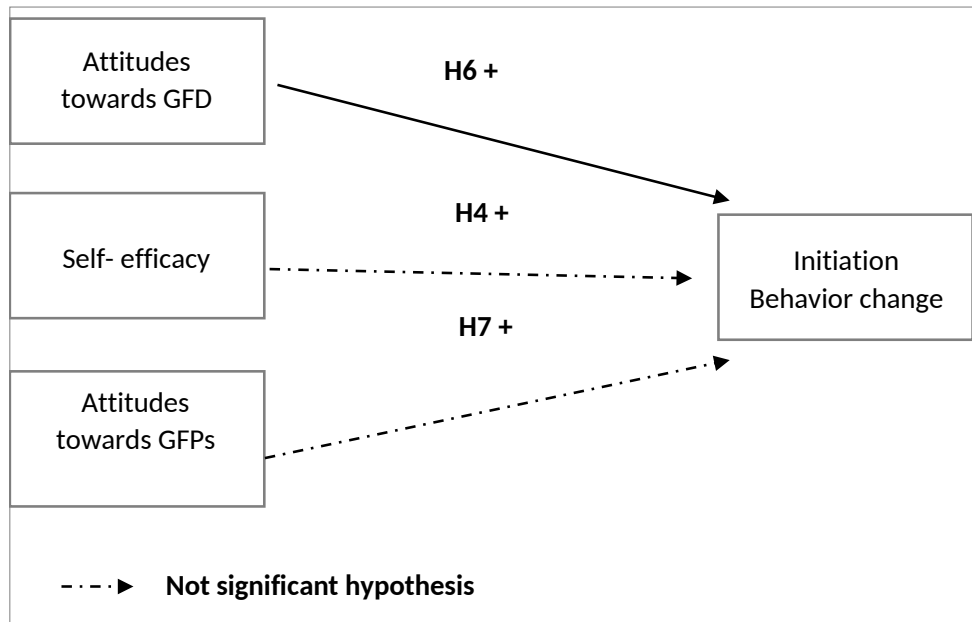


Figure 9 Results of MTM (initiation model) on intention to start following GFD

Regarding the continuation model, we applied it only to the followers of GFD. However, our analysis found that none of the factors explains the continuation of the GFD. Thus, we cannot confirm any of the hypotheses we put forward in this study regarding the continuation model.

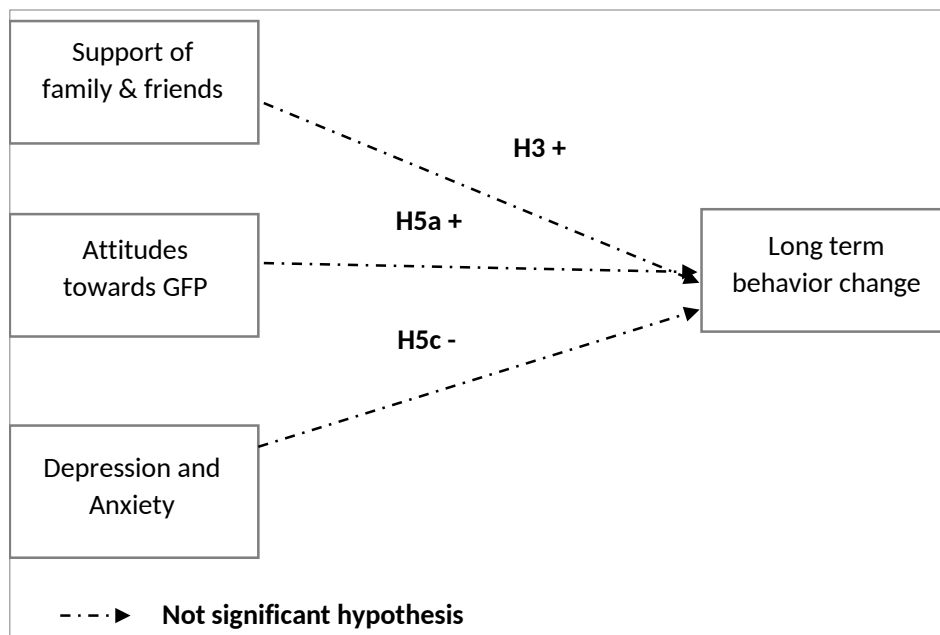


Figure 10 Result of MTM (continuation model) on adherence to GFD

4. Discussion

Recently, a high number of people are following the GFD. Apart from celiac patients, non-celiac people are also embracing the GFD. The reasons for this behaviour are different, but most of them follow the GFD because prescribed by a health professional since GFD, according to some research, might improve symptoms of other diseases. Also, family members of celiac people are following the GFD at home to avoid possible food contamination. Furthermore, other non-celiac people are voluntarily following the diet because they believe it is healthier and helps them stay in shape. However, to date, research has not verified these beliefs. On the contrary, it has been shown that GF products suffer from low nutritional properties. Hence, this research aimed to shed light on some of the main factors affecting adherence to GFD for celiac and non-celiac people by considering health behaviour models. The IM and MTM models were taken into account since IM includes all the previous theories on health behaviour, and MTM is one of the most recent theories in the field. Both models have overcome some limitations of previous theories on health behaviour.

Results show that adherence to GFD is affected by beliefs and attitudes towards the diet. It was found that believing that GFD improves the symptoms of CD, that a GFD should only be started if it is prescribed by a health professional, and that people who follow GFD have a healthier diet, explain adherence to GFD. However, to date, research has no evidence that GFD helps to lose weight. These results are in line with other studies that have found that perceptions on GFD are fundamental when embracing the GFD (Leffler et al., 2009, 2008; Sainsbury & Mullan, 2011; Villafuerte-Galvez et al., 2015).

Furthermore, this study found that self-efficacy and injunctive norms that is, what other family members and close friends think a person should do, are also essential factors that should be taken into account when trying to understand the behaviour towards GFD. Previous studies have found similar results. According to Ford, Howard, & Oyebode (2012), perceived self-efficacy should be considered for psychological interventions for individuals with CD.

Finally, background factors, such as knowledge and perceptions that GF products are expensive, are explaining adherence to GFD. Other studies have also found that people with a high level of

827
828
829 knowledge regarding GFD have higher possibilities to follow a strict GFD (Leffler et al., 2008;
830 Muhammad et al., 2017; Rajpoot et al., 2015; Rocha, Gandolfi, & Dos Santos, 2016; Jocelyn A.
831 Silvester, Weiten, Graff, Walker, & Duerksen, 2016; Villafuerte-Galvez et al., 2015). Other studies
832 have also found that GF products are generally perceived as expensive by the participants, either
833 celiac or non-celiac (Araújo & Araújo, 2011; Bacigalupe & Plocha, 2015; do Nascimento, Medeiros
834 Rataichesk Fiates, dos Anjos, & Teixeira, 2014; Ferster et al., 2015; Leffler et al., 2008; Rajpoot et
835 al., 2015; Tomlin, Slater, Muganthan, Beattie, & Afzal, 2014).

836
837
838 Previous research on GFD has found that QOL and depression and anxiety levels are important factors
839 in explaining the behaviour towards GFD (Barratt, Leeds, & Sanders, 2011; Borghini et al., 2016;
840 Francesc Casellas et al., 2008; Francisco Casellas et al., 2015; CASTILHOS et al., 2015; SriHari
841 Mahadev, Gardner, Lewis, Lebwohl, & Green, 2015; Paarlahti et al., 2013; Peters, Biesiekierski,
842 Yelland, Muir, & Gibson, 2014; Rose & Howard, 2014; Sainsbury & Mullan, 2011; Sainsbury,
843 Mullan, & Sharpe, 2015a, 2013b; Ukkola et al., 2011, 2012b). However, in this study, we did not find
844 the same results. It is important to stress that, to date, studies have measured factors affecting
845 adherence to GFD by separately considering celiac and non-celiac patients who follow GFD. Hence,
846 future research must examine both groups simultaneously to prove the results of this study.
847
848

849 Another key point of this study was to find out how health behaviour models, IM and MTM,
850 explaining adherence to GFD. We found that all constructs of the IM explain well adherence to GFD,
851 which, according to IM, is affected by attitudes towards GFD, injunctive norms, self-efficacy and
852 background factors, such as knowledge and attitudes towards GF products. Regarding the MTM,
853 instead, the constructs of the continuation models failed to explain adherence to GFD. Still, we found
854 that intentions to start following the GFD depend on attitudes towards it. Nevertheless, other studies
855 have found that MTM is a good predictor for both starting and continuing the behaviour (M Sharma
856 et al., 2017; Manoj Sharma, 2017; Manoj Sharma et al., 2017, 2016). Still, it is important to stress the
857 fact that in this research, for the continuation model we measured the actual behaviour (adherence to
858 GFD) and for the initiation model the intention to start the behaviour (initiating the GFD). Thus,
859 further research is important to understand if the results of this study on MTM also apply in other
860 cases with real behaviour and not only the intention to engage in the behaviour.
861
862

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868 **5. References**

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