Current beliefs towards dairy and lactose intolerance among university students from Hordaland (Norway) and Catalonia (Spain)

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ABSTRACT

Purpose: The aim of the present study was to identify factors that influence beliefs about dairy and lactose intolerance (LI) and to describe the regionalism of this influence**.**

Design and Methods: Online questionnaire-based study on university students from Catalonia, Spain (n=196) and Hordaland, Norway (n=132). We used standardized factor scores as a continuous measure of beliefs and analyzed its association with different factors using a linear mixed model, stratified by region.

Findings: In Hordaland, only socio-demographic variables were associated to beliefs, suggesting a positive influence of social norms, probably driven by a stable and long tradition of dairy consumption and low LI prevalence. In Catalonia, participants enrolled in a masters or a health-related discipline scored higher, suggesting an active acquisition of beliefs.

Value and Practical implications: Our results put into evidence the importance of assessing the characteristics of each community in order to develop tailored interventions aimed at improving students' beliefs about dairy.

Keywords: *dairy; lactose intolerance; beliefs; Norway; Spain*

Introduction

Dairy in general, and milk in particular, are essential sources of calcium and other crucial nutrients (Vissers et al. 2011). Failure to meet calcium consumption requirements has been associated to higher likelihood of bone fracture and other bone-related problems, mainly osteoporosis (Rizzoli et al. 2014; Rizzoli 2008; Rozenberg et al. 2016). In addition, epidemiological evidence suggest dairy would be protective against cardiovascular-related outcomes (Kliem & Givens 2011), and possibly some cancers (i.e. colorectal cancer)(WCRF & American Institute for Cancer Research 2011). Despite its benefits and intake recommendations, dairy consumption shows a descending trend (Kearney 2010; Dror & Allen 2014; International Dairy Federation and Statistics Canada n.d.) and a lack of compliance with the dairy consumption recommendations (Mahon & Haas 2013; Wham & Worsley 2003), which is aggravated by the tremendous increase in popularity of plant-based drinks with sells raising at expenses of a drop in the dairy market (Whipp 2016).

From social epidemiology, there is growing interest in describing the social factors that may impede compliance with dairy recommendations. Within this research paradigm, the **Theory of Reasoned Action (TRA)**(Ajzen & Fishbein 1980) is one of the most widely applied behavioural theories to explain variance in behaviour. According to this theory, a person's behaviour is dependent on his intention to perform which is influenced by the subjective norms—i.e. a reflection of the normative beliefs and the motivation to comply—, and the attitudes towards the behaviour. The latter is directly dependent on the beliefs about the behaviour outcomes and their final evaluation (Figure 1).

For dairy, evidence shows that attitudes and beliefs, mainly about the outcomes of consuming dairy, are the elements that better explain the intention to consume (Kim et al. 2003; Armitage & Conner 2001). Therefore, identifying the factors influencing the creation of such beliefs may help to understand the lack of compliance with the dairy consumption recommendations (Mahon & Haas 2013; Wham & Worsley 2003). The existence of erroneous beliefs, sometimes referred as fallacies or myths, is a recognized problem involving both dairy general knowledge as well as lactose intolerance (LI) and its management(Zaitlin et al. 2013; McBean & Miller 1998).

LI is a physiological condition characterized by a reduction in the lactase enzyme function during early adulthood, eventually causing lactose indigestion. Despite restricted consumption of dairy is often recommended, most patients show a residual lactose tolerance. Thus, complete avoidance of dairy should not be promoted due to the potential negative impact it may have in the individual's health if there is no appropriate adjustment in the diet ocurrs. However, evidence shows that most LI individuals, and especially those self-reported, practically eliminate dairy from their diets (Zingone et al. 2017; Carroccio et al. 1998; Casellas et al. 2016; Barr 2013). This behaviour has been associated with mistaken beliefs regarding LI and its management. Similar patterns have been seen for the general population with mistaken beliefs affecting general knowledge on dairy, especially promoted through the mass media (Lacroix et al. 2016). All these mistaken beliefs are especially important in young adults since this is the period when first own-based nutritional decisions are made and lifelong lifestyles are built (Demory-Luce et al. 2004; Larson et al. 2009). Beliefs acquired during young adulthood are likely to remain and have a lasting impact on health (Nicklas 2003).

Given the importance of beliefs it becomes essential to determine which factors may influence them. Factors such as gender, age and education have been shown to impact on food selection behaviors and the beliefs they are built upon (Cooke & Papadaki 2014; Matthews et al. 2016; Yahia et al. 2016). The association of each of these variables with beliefs is extremely dependent on the attributes of the community under study. Characteristics such as social structure, tradition or even LI prevalence and its social acceptance, may shape how specific social and educational factors influence beliefs. Therefore, different settings are expected to show different underlying factors with an influence on beliefs.

Herein, we aimed to describe the association of socio-demographic and educational factors with correct beliefs about dairy and LI among university students from two European regions (i.e. Hordaland, Norway; Catalonia, Spain). These regions have especially different socio-demographic and educational characteristics, dairy consumption rates, as well as LI prevalence. Thus, they were regarded as a unique opportunity to compare different contexts.

Methods

Participants and Recruitment

Participants were university students aged 18 to 30 years old studying in Catalonia—Autonomous community of north-eastern Spain (n=196)—and in Hordaland—south-western county in Norway (n=132). Participants were recruited primarily using two reference universities in each area with a call to dissemination to other institutions. Being an exchange student and having language barriers were considered exclusion criteria.

Participation was voluntary and information regarding the aims of the study and the confidentiality of the data was provided to all participants. Informed consent was obtained when participants completed the questionnaire online. Students were appropriately informed of their right to withdraw from the study at any time. Data were anonymous, non-sensitive and contained no information that could potentially allow identification of the participants.

The questionnaire

The questionnaire was specific to assess the association between the explanatory variables (i.e. socio-demographic and educational contexts) and correct beliefs about dairy and LI. For the social context, explanatory variables included gender and age, whereas for the educational context we included the field of bachelor's degree (i.e. social sciences and law, science, health sciences and bioscience, arts and humanities, or technology) and the type of university studies (i.e. bachelor's, masters or PhD). People with LI are expected to receive extra education on LI and its management, therefore information on LI status (i.e. LI or non-LI) of the individual and their acquaintances was also collected.

The questionnaire was available online for 2 months. Two online announcements were made at the official social-network sites of all schools of each university reference university. A call to dissemination to other institutions was included. The questionnaire was translated to Catalan and Spanish—both co-official languages in Catalonia—, and to English—for Norwegian students. Norway occupies the fifth position in the Education First English Proficiency Index 2016 ranking (EF EPI) for English proficiency; thus, no language barrier was expected. The complete English version of the questionnaire—questions labeled Q1 to Q15— can be found in Supplementary Material, Table S1.

Operational definitions of the items were based on a profound literature review. The questionnaire then underwent a three-stage validation. The first stage included an assessment of the relevance of the content by an expert in medical physiology, nutrition and health (i.e. *expert validation*). Secondly, a *cognitive validation* was carried out separately for English and Catalan/Spanish versions of the questionnaire on a reduced sample of university students from Hordaland and Catalonia, respectively. Structural, wording and formatting issues were addressed similarly across all the questionnaire versions. Language-specific changes were applied specifically to each questionnaire.

The third stage assessed the internal structure of the questions (i.e. *convergent validation*). For this purpose, we considered the pooled data from all questionnaire versions because sample size was deemed small for a multiple-group analysis. We assumed both the existence of (i) a *latent construct* (i.e. beliefs under study), and (ii) a causal relationship from this construct to the items Q1 to Q15—i.e. *reflective indicators.* All items were coded as follows: '0' for incorrect or 'I don't know' answers; '1' for correct answers. Accordingly, tetrachoric correlations were estimated (Olsson 1979) (Table S2). Empty cells in the contingency tables and low/negative correlations with all other items were considered as arguments for item exclusion (i.e. Q4, Q5, Q7, Q8, Q11, Q12). The dimensionality of the remaining items was checked by means of a one-dimension exploratory factor analysis (EFA) model on tetrachoric correlations (a two-dimension model provided no better fit, p-value=0.22 for the nested-model test) estimated with Mplus7 (Muthén & Muthén 2012). Threshold parameters were interpreted as item difficulties and factor loadings as item discriminations (Table 1). The item ordering according to difficulty, from less to more difficult was Q6, Q15, Q1, Q14, Q9,

Q10 and Q3. From their factor loadings, all items showed to be representative of and relevant to the targeted construct.

Standardized factor scores were used as a continuous measure of beliefs in all subsequent statistical analysis. As a sensitivity check, a two-parameter Item Response Theory (IRT) model was fitted, yet the correlation between IRT abilities and EFA factor scores was 0.999 (data not shown). EFA was the elected model. A more detailed description of the three-stage validation process can be found in Supplementary Material, "Detailed validation procedure" section.

Data analysis

Questionnaires with missing answers were excluded (n=5). All answer categories of each explanatory variable was considered for analysis except for the variable 'field of studies' which was recorded as dichotomous (i.e. 'health sciences and biosciences' and 'others'). The association of the explanatory variables with beliefs was assessed for each region separately by means of a linear mixed model stratified by region. We used a linear (regression model) because our dependent variable—i.e. standardized factor score— was continuous, and a mixed model because we included random effects to capture individual heterogeneity, that is to say, unobserved factors specific to individuals, which could also explain the variation in the dependent variable.

Results are presented as the variation in the standardized factor scores as compared to the reference category and given in standard deviation (SD) units. Negative and positive values must be interpreted as a decrease or increase in the factor scores compared to the reference category, respectively. All analyses were performed with the R software (version 3.3.2). Statistical significance was set at $p<0.05$ and confidence intervals at 95% (95%CI).

RESULTS

Population Description

Table 2 shows the demographic characteristics for the two studied regions. Overall, 193 Catalan and 132 Norwegian university students successfully completed the questionnaire. Gender distribution was similar in both populations, with participation being higher in women. The overall mean age (SD) was 21.90 (2.42) years with the most prevalent age range being 20 to 24 years in both regions (72.73%, Hordaland; 74.09%, Catalonia). The second most common age range differed between regions, 25 to 30 years in Hordaland (19.70%) and 18 to 19 years in Catalonia (16.06%).

Overall, 263 (80.92%) of the questionnaires were completed by undergraduate students whereas postgraduate students represented a 30.30% in Hordaland and an 11.40% in Catalonia. Of all Catalan students, more than half (55.96%) were enrolled in health science and bioscience studies, with any other field of studies representing more than 13%. Conversely, Norwegian students were more evenly distributed through the different fields. There was no significant difference either in the proportion of LI participants (15.69% overall) or in the proportion of participants who had acquaintances with LI (87.08% overall).

Factors affecting beliefs

The association between the socio-demographic and educational variables with the correct beliefs about dairy and LI is presented in Table 3 for each region.

Norwegian University Students

In Hordaland, a significant association was found for gender, with women reported to perform better than men by 0.38SD (95%CI: 0.11; 0.65). Belief scores increased with age,

showing 0.52SD (95%CI: 0.12; 0.93) and 0.83SD (95%CI: 0.37; 1.29) better performance for students aged 20 to 24 and 25 to 30 years, respectively. No interaction was found between gender and age (data not shown) and no significant association was found for field and level of studies.

Catalan University Students

In Catalonia, students enrolled in a Masters' program performed better by 0.43SD (95%CI: 0.01; 0.84) compared to graduate students. Likewise, students enrolled in health-related studies showed higher belief scores by 0.41SD (95%CI: 0.20; 0.61). No interaction was found between field and level of studies (data not shown) and no significant association was found for age or gender.

Discussion

Evidence shows that an alarming number of people have erroneous beliefs regarding dairy and the definition and management of LI(Zaitlin et al. 2013; McBean & Miller 1998). According to the TRA behavioral model, erroneous beliefs regarding dairy may be detrimental for its consumption and thus, be shaping the negative trend seen for dairy consumption. Oppositely, correct beliefs may allow for an improvement or reversal of such negative trends(Mahon & Haas 2013; Wham & Worsley 2003). Herein, we provide evidence on which specific socio-demographic and educational factors are associated with correct beliefs about dairy and LI by region, i.e. Catalonia (Spain) and Hordaland (Norway), and thus, that could be used to tailor interventions aimed at increasing dairy consumption.

Hordaland, the Role of Social Inputs

For Norway, women and the older groups of university students were shown to more frequently have correct beliefs, which is consistent with the literature(Tallarini et al. 2014; Yahia et al. 2016; Cooke & Papadaki 2014). For women, a higher interest and care for their health status and physical appearance(Tallarini et al. 2014; Bibiloni et al. 2013) would account for it.

These variables are purely socio-demographic, i.e. outside the education system. Therefore, we suggest that they are a reflection of the social norms associated to dairy consumption. According to the 'gene- culture co-evolutionary theory' (Frederick J. 1970), dairy consumption would have been adopted as a cultural behaviour during *Neolithization* in Northern Europe. Thereafter, this region would have showed a relatively stable dairy tradition, turning dairy consumption into a well-rooted behaviour and shaping the prevalence of LI. Currently, Norway holds one of the lowest rates of LI prevalence, below 5% (Tuula H et al. 2000), indicating the absence of any major physiological burden to dairy consumption (Ingram et al. 2009) and thus, no extra negative perception associated to dairy. Taken together, the early introduction of dairy in Scandinavia, the low prevalence of LI and the current high consumption rates, show that milk consumption is a well-rooted practice within the Norwegian community and thus, suggest it has positive social norms associated that may be shaping the creation of correct beliefs.

According to the TRA, this favourable social context would translate into a positive social support and favourable normative beliefs about dairy, indirectly influencing students' beliefs. The associations found for women and older participants further support this hypothesis.

Catalonia, the Role of Education

In Catalonia, field and level of studies were the two variables that best explained beliefs. Accordingly, respondents were more likely to answer correctly if they were enrolled in a master's program or in health-related studies. According to the Knowledge-attitude behaviour (KAB) model (Figure 1b) (Schneider & Cheslock 2003; Baranowski et al. 2003), knowledge accumulation is key for attitude change. Therefore, the gain in knowledge of a certain behavior leads to a change in attitude, finally impacting on the behavior itself. Evidence shows that increased general nutrition knowledge— and specifically dairy-related knowledge—is a powerful predictor of food label use (Miller & Cassady 2015), dietary dairy guidelines application to daily practices (Escalon et al. 2013; Kolodinsky et al. 2007) and dietary habits (Cooke & Papadaki 2014; Kolodinsky et al. 2007; Sharma et al. 2008). Therefore, we sustain that health-related studies in Catalonia may provide with reliable knowledge on nutritional concepts, and more specifically regarding dairy and associated conditions, such as LI. These may favor the production of correct beliefs among Catalan university students.

Alternatively, social-related educational variables such as gender and/or age showed no significance. This can be explained by both the late and intermittent historical establishment of dairy consumption as well as the high LI prevalence of the region. In Southern Europe, the introduction of dairy was delayed compared to Scandinavia and its adoption was intermittent due to the interaction with already existing practices and the additional migration influxes from other regions of the Mediterranean Sea. In modern Catalonia, it was not until the late XIX century that there is proof of a generalized and steady increase in dairy consumption (Ayuntamiento de Barcelona. Negociado de Estadística 1902). In addition, LI prevalence in the region is remarkably high–i.e. 30 to 50% (Casellas et al. 2010)—and thus, hinders dairy consumption by creating negative norms associated to it. Overall, this scenario could be

regarded as less propitious in creating accurate beliefs about dairy, as opposite to what is experienced in Norway.

Taken together, attitudes and beliefs of Catalan students would be acquired in the educational context, essentially as part of the curriculum in health-related studies.

Public Health Relevance

Findings from this study contribute to the growing body of knowledge asserting the factors that influence dairy and LI beliefs and, eventually, dairy consumption. The findings herein reported support the existence of fallacies around dairy and provide evidence on the local/regional factors affecting influencing beliefs. This highlights the need for setting-specific assessment and interventions. For Catalonia, for example, our results suggest that interventions involving transmission of correct knowledge regarding dairy could an impact on the population beliefs about it.

Overall, this provides public health advisors with key information on how beliefs are being differently affected by sociodemographic and educational factors and gives them a better understanding of the complex framework that shapes consumption behaviors in different settings. This can then be used to create appropriate and tailored interventions triggered to raise dairy consumption where needed. Countries like Spain, with a high prevalence of LI individuals, are especially susceptible to the negative impact of fallacies around LI and thus, would particularly benefit from such preventive campaigns.

Limitations and Strengths

The major limitation of this study is the voluntary selection bias that may affect our sample. However, main variables that could eventually be affected by it were included in the model.

Also, educational plans were considered to be unique for each field of studies dismissing the existence of any program or local campaign implemented across more than one field of studies touching upon dairy. A review of the educational curricula and a content analysis of the national and local campaigns could be a meaningful extension to the present work. In terms of the external validity, the highly specific attributes of each setting make generalization of the results difficult. Nonetheless, in it also lies its great value as it demonstrates the importance of the setting in shaping the impact each factor has in beliefs about dairy and LI, putting into evidence the need for setting-specific assessment.

For this study, the TRA behavioural model provides arguments that support the importance of beliefs in terms of behaviour intention. However, the evaluation of behaviour itself falls out of the scope of the present work and thus, remains as a potential future line of research.

An important strength of the present study is the use of a wide array of questionnaire validation methods— i.e. *expert, cognitive and convergent validation*. The remarkable size of the sample, the availability of data for two highly opposed European regions in terms of dairy culture and consumption rates, and the clinical relevance of the age-group herein assessed, add further value to this study.

Conclusions

This study is unique in that it provides evidence on how beliefs about dairy and LI are influenced by different socio-demographic and educational factors in a way that is strongly dependent on the region under study. For Catalonia, beliefs were greatly dependent on education, as opposite to Hordaland, where a favourable social and historical context seemed to be the major influence.

The results herein presented put into evidence the need to further study the characteristics and necessities of each community in order to be able to shape the interventions as required. This will help governments and industries to develop tailored interventions aimed at improving students' beliefs about dairy.

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Tables

Table 1. Results of a one-dimension exploratory factor analysis (EFA) on tetrachoric correlations.

	Threshold parameters[a]	Factor loadings[b]
Q1	-0.788	0.507
Q3	-0.035	0.514
Q6	-1.060	0.362
Q9	-0.620	0.443
Q10	-0.417	0.402
Q14	-0.677	0.515
Q15	-1.046	0.529

[a] Threshold parameters interpreted as item difficulty
[b] Factor loadings interpreted as item discrimination

Table 2. Population characteristics of the samples from Hordaland (n=132) and Catalonia (n=196).

	Total		Hordaland (Norway)		Catalonia (Spain)		
Characteristics	**N**	**%**	**N**	**%**	**N**	**%**	**P-value**
Gender							
Women	241	74.2	105	79.6	136	70.5	0.066
Men	84	25.9	27	20.5	57	29.5	
Age group							
18-19	41	12.6	10	7.6	31	16.1	0.007
20-24	239	73.5	96	72.7	143	74.1	
25-30	45	13.9	26	19.7	19	9.8	
Mean age (SD)	21.90	(2.4)	22.59	(2.6)	21.42	(2.2)	
Level of studies							
Bachelor's	263	80.9	92	69.7	171	88.6	<0.005
Master's	57	17.5	40	30.3	17	8.8	
PhD	5	1.5	0	0	5	2.6	
Field of studies							
Science	51	15.7	26	19.7	25	13.0	<0.005
Health sciences and biosciences	143	44.0	35	26.5	108	56.0	
Social sciences and law	66	20.3	41	31.1	25	13.0	
Technology	25	7.7	8	6.1	17	8.8	
Arts and Humanities	40	12.3	22	16.7	18	9.3	
LI status							
LI	51	15.7	26	19.7	25	13.0	0.101
Non-LI	274	84.3	106	80.3	168	87.1	
Acquaintances with LI							
No	42	12.9	22	16.7	20	10.4	0.096
Yes	283	87.1	110	83.3	173	89.6	
Total	325	100.0	132	100.0	193	100.0	

Table 3. Estimates of the association of socio-demographic and educational variables with beliefs by region.

	Hordaland (Norway) (n=132)			Catalonia (Spain) (n=196)		
Demographic characteristics	**Estimate**	**95% CI**	**p-value**	**Estimate**	**95% CI**	**p-value**
Gender						
Men	0			0		
Women	0.38	(0.11;0.65)	0.006	-0.00	(-0.22; 0.22)	0.984
Age group						
18-19	0			0		
20-24	0.52	(0.12; 0.93)	0.012	0.20	(-0.06; 0.46)	0.126
25-30	0.83	(0.37; 1.29)	<0.001	0.12	(-0.36; 0.60)	0.628
Level of studies						
Bachelor's	0			0		
Master's	0.11	(-0.12; 0.34)	0.348	0.43	(0,01; 0.84)	0.044
PhD	-	-	-	-0.25	(-0.88; 0.38)	0.444
Field of studies						
Others[a]	0			0		
Health sciences and biosciences	0.16	(-0.07; 0.40)	0.178	0.41	(0.20; 0.61)	<0.001

SD, Standard deviation; 95% CI, 95% confidence interval.
Multivariate linear regression model adjusted for all the studied covariates as well as LI status and acquaintances with LI . First group is the reference group for all statistical comparisons. Difference with respect to reference group in factor scores standard deviation (SD) units.
[a] Others includes: Science, Social sciences and law, Technological sciences and Arts and Humanities

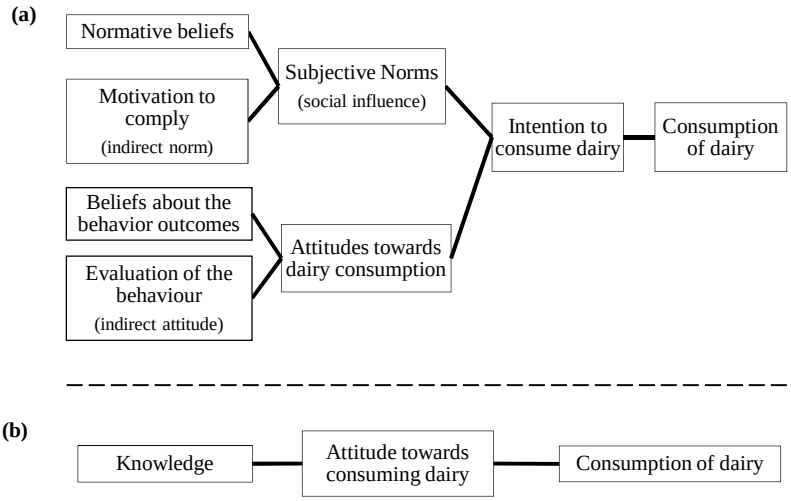

Figure 1. Elements conditioning behavior according to (a) the Theory of Reasoned Action, TRA and (b) the Knowledge-Attitudes-Behavior (KAB) model.

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SUPPLEMENTARY MATERIAL

Table S1. English complete version of the questionnaire after cognitive validation[¥].

Questions	Correct answer	Correct answers (%)		
		Total	Hordaland (Norway)	Catalonia (Spain)
Lactose intolerance				
Q1. Is lactose intolerance an allergy?	Yes / <u>No</u>	78.5	71.2	83.4
Q2. Do all foods contain the same amount of lactose?	*Yes / <u>No</u>*	-	-	-
Q3. Which other animals can digest lactose as adults a part from humans?	All mammals/Only terrestrial mammals/ All type of animals, not only mammals/ <u>None of the others</u>	51.4	39.4	59.6
Q4. Which percentage of people do you think is lactose intolerant IN THE WORLD?	*<u>65%</u> / 25% / 85%*	-	-	-
Q5. Which region has a higher lactose intolerance prevalence?	*Southern European countries (e.g. Spain, Italy, Greece…) / Scandinavian countries (e.g. Norway, Sweden…) / <u>Southern African countries</u>*	-	-	-
Q6. Do people with lactose intolerance need any nutritional supplement?	Yes / <u>No</u>	85.5	82.6	87.6
Q7. *The MAJORITY of lactose intolerant people...*	*...can NOT eat any lactic product. / <u>...can eat some lactic products</u>. / ...can eat all kinds of lactic products but with moderation*	-	-	-

Myths and mistaken beliefs				
Q8. Drinking milk promotes mucus.	True / <u>False</u>	73.2	70.5	75.1
Q9. Milk consumption promotes gain of weight.	True / <u>False</u>	-	-	-
Q10 Drinking milk immediately after food intoxication (e.g. mushrooms poisoning) protects your stomach of further harm.	True / <u>False</u>	66.2	55.3	73.6
Q11. *Milk help you to have a glowing skin.*	*<u>True</u> / False*	-	-	-
Q12. *A glass of hot milk before going to sleep helps you to fall asleep.*	*<u>True</u> / False*	-	-	-
Q13. *The liquid (whey) on top of the yogurt should be removed because it is NOT healthy.*	*<u>True</u> / False*			
Q14. Pasteurization destroys the majority of the nutrients so raw milk is better.	True / <u>False</u>	75.1	63.6	82.9
Q15. Only processed and manufactured milk contain Growth Hormones/Factors(GH/GF).	True / <u>False</u>	85.2	80.3	88.6

[¥] In *italics* those questions dismissed for the final analysis after convergent validation.

Table S2. Tetrachoric correlations.

	Q1	Q3	Q6	Q9	Q10	Q14	Q15
Q1	1.000						
Q3	0.261	1.000					
Q6	0.320	0.276	1.000				
Q9	0.248	0.063	0.096	1.000			
Q10	0.203	0.241	0.040	0.188	1.000		
Q14	0.145	0.303	0.172	0.336	0.195	1.000	
Q15	0.272	0.289	0.060	0.300	0.234	0.234	1.000

[a] Threshold parameters interpreted as item difficulty
[b] Factor loadings interpreted as item discrimination

Detailed validation procedure

The validation of the questionnaire consisted of three assessment stages, as follows:

Expert validation

An associate professor of medical physiology and experienced investigator in nutrition and health topics assessed the questions individually and as whole with a main focus in content relevance. The assessment was conducted on all the versions of the questionnaire by the same expert, who was fluent in all relevant languages.

Cognitive validation

The cognitive validation consisted of a pilot test conducted on a reduced sample of university students (n=5). The test was run both in Hordaland and Catalonia in order to assess the suitability of the English and Catalan/Spanish versions of the questionnaire, respectively. Respondents were requested to give their opinion on the structure and content of the questionnaire as well as on their suitability in terms of use of the language and content.

All feedback provided regarding the content, structure and format of the questionnaire was considered for improvement. Comments were applied across all versions of the questionnaire. Some of the suggestions included: (i) to incorporate the subheadings “Lactose intolerance” and “Myths and facts” to better guide the respondents through the questionnaire; (ii) to add an example of food intoxication in Q10 for a better comprehension, or (iii) to use the adjective ‘nutritional’ to specify the type of supplements referred to in Q6. More language- and comprehension-related comments where applied specifically to the language version they referred to.

Convergent validation

Finally, the internal structure of the questionnaire was evaluated for all versions combined. For this purpose, we assumed (i) the existence of a *latent construct* (i.e. beliefs under study), and (ii) the existence of a causal relationship from this construct to the items Q1 to Q15—i.e. *reflective indicators*. All questions were codified using a 0/1 code ('0' for incorrect or 'I don't know' answers; '1' for correct answer).

A common approach to modelling binary variables is to assume that for each observable binary variable y_i there is an underlying standardized normal variable y^*_i and that y_i is related to y^*_i through the step-function:

$$\textbf{Eq(1)} \quad y_i = 1 \text{ when } y_i^* > \tau_i$$

$$y_i = 0 \text{ when } y_i^* \leq \tau_i$$

where τ_i are called thresholds and are related to the frequency distributions (the higher the threshold, the lower the frequency of 1 responses). Eq(1) leads to the use of tetrachoric correlations. Tetrachoric correlations estimate the relationship between the underlying y^* variables and are a particular case of polychoric correlations (Olsson 1979) and of Muthén's categorical variable methodology (Muthén 1984). Items with low or even negative correlations with all other items were removed from further consideration (i.e. Q4, Q5, Q7, Q8, Q11, Q12) in a first step.

In a next step, the dimensionality of the remaining items Q1, Q3, Q6, Q9, Q10, Q14 and Q15 was checked by means of an exploratory factor analysis (EFA) model. Mplus 7 was used for estimation (Muthén & Muthén 2012) with the diagonally weighted least square estimation method on tetrachoric correlations in Table S2 (WLSMV option in the Mplus program). The one-dimension model was not rejected by the mean-and-variance adjusted chi-square test (p-value 0.41), and the two-dimension model had no significantly better fit than the one-dimension model (nested-model p-value 0.22). Eigen values of the thetrachoric correlation matrix (screeplot in Figure 1) and the goodness of fit of the one-dimension model (CFI=0.993; TLI=0.989; RMSEA= 0.011) also pointed to a one-dimension solution. Therefore, only one dimension was considered (i.e. beliefs under study). Threshold parameters are interpreted as item difficulties and factor loadings as item discriminations. The item ordering according to difficulty, from less to more difficult is Q6, Q15, Q1, Q14, Q9, Q10, Q3. A negative threshold (i.e., low difficulty) means that more than 50% of the

sample answer correctly. From their factor loadings, all items showed to be representative of and relevant to the targeted construct.

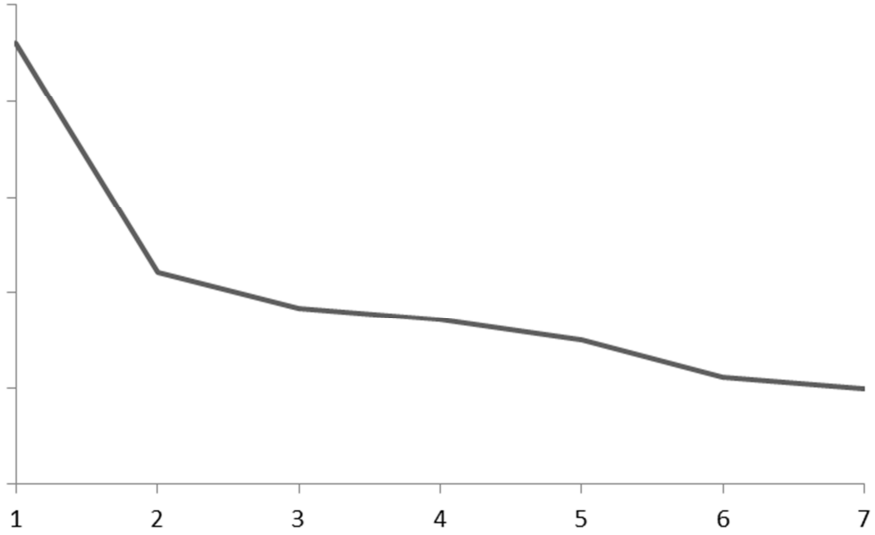

Figure S1. Eigenvalue screeplot

Factor scores were used as individual measures for beliefs about lactic products, after standardization to zero mean and unit standard deviation. A two-parameter Item Response Theory (IRT) model (Wilson 2008)—was also used to check to what extent model choice could affect the results. The correlation between IRT abilities and EFA factor scores was 0.9994 arguing for the results' insensitivity to model specification.

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