International Dairy Journal 96 (2019) 85–92

Contents lists available at ScienceDirect

International Dairy Journal

journal homepage: www.elsevier.com/locate/idairyj

Milk-borne infections awareness and the health status of consumers: An on-line survey

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ARTICLE INFO

Article history:
Received 6 December 2018
Received in revised form
11 April 2019
Accepted 15 April 2019
Available online 30 April 2019

ABSTRACT

Despite clear health risks associated with consuming unpasteurised milk, a considerable number of people are still consuming these products. We evaluated consumers' behaviour and perceptions about food safety risks related to raw milk and unpasteurised cheese product consumption, associating their awareness of foodborne diseases with the epidemiology of gastro-intestinal disorders. A cross-sectional study in Brazil was conducted using an online standard questionnaire. The consumption of raw milk and dairy products is widespread. Although 66% of consumers are misinformed about regulations, 90% of consumers are conscious about the risks of raw milk consumption. The level of awareness of milk-borne diseases is not equal across age and educational level. Although our results should be generalised with caution, we found that awareness of milk-borne diseases is a protective factor against abdominal pain, concluding that the ability to understand the risks of unpasteurised dairy product consumption was associated with health status of the population.

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1. Introduction

The infection risks associated with consuming raw milk are clear and undisputed. Even milk obtained from clinically healthy cows can be contaminated with pathogens (Lucey, 2015). Most recently, the consumption of bulk milk sold directly from the producer was associated with higher probability of haemolytic uraemic syndrome (Ntuli, Njage, Bonilauri, Serraino, & Buys, 2018). Thus, we must consider that raw milk may pose a risk to public health.

In view of this concern, milk pasteurisation for direct human consumption or for fresh cheeses production is mandatory in many countries, including Australia (ANZ Authority, 2016) and Brazil (Brasil, 2017). However, more flexible conditions can be found in other countries, such as in the United States, where in the last raw milk survey, 30 states allowed raw milk sales, while 20 states still prohibit it (NASDA, 2011). In some countries, such as the UK, the situation can be more permissive, and raw milk may be sold directly to consumers. However, strategy by the UK to reduce risks is more established, and the raw milk must be from an official brucellosis and tuberculosis-free herd. In addition, the milk must bear a health warning label and must be sold only by registered milk production holdings or through milk roundsmen (UK Government, 2006).

Throughout history, mandatory pasteurisation and raw milk sales regulations are associated with a decreased of milk-borne disease outbreaks. Before the 1950s, about a quarter of all foodborne infections were attributed to milk (USDHHS, 2009). Following the introduction of regulations recommending milk pasteurisation, milk was involved with less than one percent of reported foodborne disease outbreaks (Gould et al., 2011). However, in recent years this number seems to be increasing as more countries have allowed the legal sale of raw milk. For example, in the USA the average number of outbreaks linked to raw milk each year was four times higher from 2007 through 2012 than from 1993 through 2006 (Mungai, Behravesh, & Gould, 2015). In addition, the percentage of outbreaks associated with raw milk increased from 2% to 5% from 2007 to 2009 through 2010–2012 (Mungai et al., 2015).

Despite the health risks associated with consuming unpasteurised milk, and in some cases, its illegal sale, a considerable number of people are still consuming these products. Even where the government restrict legal sales, the raw milk and raw dairy products can be purchased on the informal market. Nowadays, there is a popular discussion about the risks and benefits from the consumption of raw milk, but currently, all scientific works and reviews have categorically concluded that there is no evidence that

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https://doi.org/10.1016/j.idairyj.2019.04.013
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raw milk has any inherent health or nutritional benefits that overcome its risks (MacDonald et al., 2011).

To combat misinformation and to increase the public health, it is worthwhile understanding the motivation for unpasteurised milk consumption (Katafiasz & Bartlett, 2011). A recent research stated that is not about consumer ignorance but rather about the acceptability of risk in the food system (Waldman & Kerr, 2018). The answers can be helpful in targeting educational efforts and strategies on consumer education by local or state health departments.

With almost 35 billion kilograms per year, Brazil is the fourth largest milk producer. However, to date, there has been no national study of consumers' awareness of milk-borne zoonotic diseases (IBGE, 2016). To the best of our knowledge, little information is available regarding epidemiological research on this field, all of them reporting descriptive studies with only a regional approach (Bassan et al., 2013; Nero, Maziero, & Bezerra, 2003; Raymundo, Bersot, & Osaki, 2017). Thus, the objective of this study was to assess the demographics, perceptions and behavioural attributes of consumers of illegal milk and dairy products in Brazil, associating, for the first time, their awareness of foodborne diseases with the epidemiology of gastro-intestinal disorders.

2. Materials and methods

2.1. Experimental design

This research project received ethical approval through the Unopar University for Human Ethics (CAAE, 2017). Informed consent was obtained from all individual participants included in the study. Study aims, activities and the voluntary nature of participation were described to each participant prior to enrolment into the study.

An online survey to investigate consumers' awareness and knowledge of milk-borne diseases was conducted between March and October 2017. The respondents were internet users and their participation was voluntary and anonymous, without any incentives for taking part in the survey and without any exclusion criteria (except for internet access). Potential participants were reached through e-mail, advertisement in the most popular Brazilian social networking sites and through instant messaging application for mobile devices. Data were collected using an online standard structured questionnaire hosted by Google Forms™, which had 24 questions in Portuguese (23 multiple choice and 1 open-ended question) (Fig. 1). Each question had to be marked (or fully answered) before continuing to the next question. To evaluate the easiness of completion and the ambiguity of questions, the questionnaire was pre-tested on a sample of 7 consumers who did not participate in the study.

The questionnaire began with a descriptive paragraph on how the results will be used to benefit the consumers and the scientific public, encouraging people to reply. Further, all information regarding ethics and approvals was provided. This methodology offers a practical way of estimating and analysing young people's perceptions (Efthymiou & Antoniou, 2012). The first part dealt with socio-demographic characteristics. The following questions addressed the consumption of milk and dairy products, the purchase frequency and the place of purchase (e.g., market, bakery, street market, delivery man, etc.). At this point, the respondents were asked about the meaning of “illegal milk and dairy products”. Independently of the answer and to standardise their knowledge, it was informed the correct definition of “illegal”, showing at the same time a representative picture of the illegal milk and dairy products being purchased on the informal market (Fig. 1). For the purposes of this study, “illegal milk and dairy products” only refers to the illegal status of its sale (i.e., uninspected milk and dairy products), without reference to other definitions.

The second part of the questionnaire addressed only the consumption of illegal milk and dairy products, asking the motivation to purchase, the awareness of Brazilian regulations restricting the sale of illegal milk and the awareness of milk-borne diseases. Participants were asked if they knew of diseases that can be carried by milk and further, if they were able to cite any disease. Finally, the third part covered the epidemiology of gastro-intestinal disorders, asking about the frequency of the most common symptoms, such as diarrhoea, vomiting, nausea, abdominal pain and the occurrence of hospitalisation due to one or more of these signs.

Three alternatives were repeated to detect invalid responding, which together, should be answered only in accordance with a reference question, and every deviation from this pattern were labelled as inconsistent.

As the milk and dairy consumer connected on internet was the target group, the appropriate sample size was based on internet users in Brazil following the formula (Luiz & Magnani, 2009):

$$Ss = (Z2 \times P(1-P))/C2 \quad (1)$$

where Ss is sample size, Z is Z value (e.g., 1.96 for a 95% confidence level), p is estimated prevalence (e.g., estimated prevalence of awareness of milk-borne diseases on population = 0.5) and C is confidence interval.

With nearly 116 million people as of 2016 (e.g., close to 65% of population), using a confidence level of 95% and 5% margin of error, we estimated that 384 cases would be required to get results that reflect the target population. The sampling was proportional to the density of the population across macro-regions in Brazil (8% North, 28% Northeast, 7% Centre-West and 57% for Southeast and South) (IBGE-SIDRA, 2016).

2.2. Statistical analysis

The socio-demographic characteristics of the consumers of unpasteurised milk were compared with those who did not consume unpasteurised milk by univariate Chi-square test. Further, the awareness of foodborne diseases in consumers of unpasteurised milk and dairy product was assessed by univariate Chi-square test, associating a dichotomic variable (are aware or are not aware) with others categorical variables (age, level of education, gender, etc.). Univariate logistic regression was also used to appraise if the awareness of milk-borne diseases can influence the chance of manifestation of each gastro-intestinal disorder and hospitalisation. Observed values less than 5 were not accessed by Chi-square. Finally, the rate for correct and incorrect answers regarding the diseases that can be carried by milk was assessed by the McNemar test, comparing the agreement between the self-perception of knowledge with the answers classified as correct by our team (Lachenbruch, 2014). All statistical analysis was performed using Statsoft Statistica software 13.0 with $p < 0.05$ being considered statistically significant.

3. Results

A total of 498 individuals responded to the questionnaire online, distributed on territory in accordance with the density of the population. No data were omitted because of inconsistent responding. The socio-demographic characteristics of the respondents are summarised in Fig. 2.

Almost all respondents (94%) stated their consumed milk and/or dairy products; the objective of this study was to assess only the information about milk consumers, therefore all subsequent data

1- How old are you?
a) Between 12-18 years b) Between 19-29 years
c) Beteween 30-59 years e) 60 years or over

2- What is your gender?
a) Female b) Male

3- Whats is your educational level?
a) Postgraduate b) Completed College
c) Completed High School
d) Completed Elementary School or less

4- Where do you live?
a) Urban area b) Rural area

5- Are you a consumer of milk or dairy products, such as cheese, yoghurts and others?
a) Yes b) No

6- How often do you consume milk or dairy products?
a) Rarely b) Sometimes c) Frequently d) Always

7- Where do you purchase dairy products?
a) Market / Bakery b) Street market / Delivery man

8- Do you know the meaning of "illegal" or "not legal" milk and dairy products"?
a) Yes b) No

Automatic message: *"Illegal" refers to non-industrialized and/or non-inspected products, usually sold as illustrated below. As an example, we can cite raw milk or any dairy product made with non-industrialized milk, usually packaged in PET bottles and/or without any kind of label or information*

9-Do you consume illegal milk and dairy products?
a)I don't consume b)Rarely c)Sometimes d)Frequently

10 - Do you avoid consuming illegal dairy products?
a) Yes b) No

11 - What illegal dairy products do you consume? (Select one or more alternatives).
a) I don't consume. b) Illegal milk.
c) Fresh cheese. d) Ripened cheese.

12 - What is the main reason that you consume illegal dairy products?
a) I don't consume. b) They are more nutritive.
c) They are practical. d) They are cheaper
e) They are pure and without chemicals.
f) They are reliable and without fraud.
g) They are my only option.
h) I consume them for other reasons.

13- Do you boil the illegal milk before consumption?
a) I don't consume b) Yes c) No

14- In your opinion, can the consumption of illegal dairy products be harmful to your health?
a) Yes b) No

15- Are you aware that some diseases can be carried by illegal milk and illegal dairy products?
a) Yes b) No

16- Do you know any disease that can be carried by non pasteurized illegal milk or illegal dairy products?
a) Yes b) No

17- Are you able to cite any disease carried by illegal milk or illegal dairy products?
__open-ended question_____

18- Are you aware of any regulation that restricts the sale of illegal dairy products?
a) Yes b) No

19- How often do you have vomiting?
a) Never b) Rarely c) Sometimes
d) Frequently e) Always

20- How often do you have diarrhea?
a) Never b) Rarely c) Sometimes
d) Frequently e) Always

21- How often do you have nausea?
a) Never b) Rarely c) Sometimes
d) Frequently e) Always

22- How often do you have abdominal pain?
a) Never b) Rarely c) Sometimes
d) Frequently e) Always

23- Have you ever been hospitalized due to any of these symptoms (vomiting, diarrhea, nausea and/or abdominal pain)?
a) Yes b) No

24- Can you remember when was the last time that you had any of these symptoms (vomiting, diarrhea, nausea and/or abdominal pain)?
a) I can't remember.
b) Less than 1 month ago.
c) Between 1 and 2 months ago.
d) Between 2 and 3 months ago.
e) 3 months ago or more.

Fig. 1. Standard structured questionnaire to investigate consumers' awareness of milkborne diseases and a representative picture used to standardise the meaning of "illegal milk and dairy products".

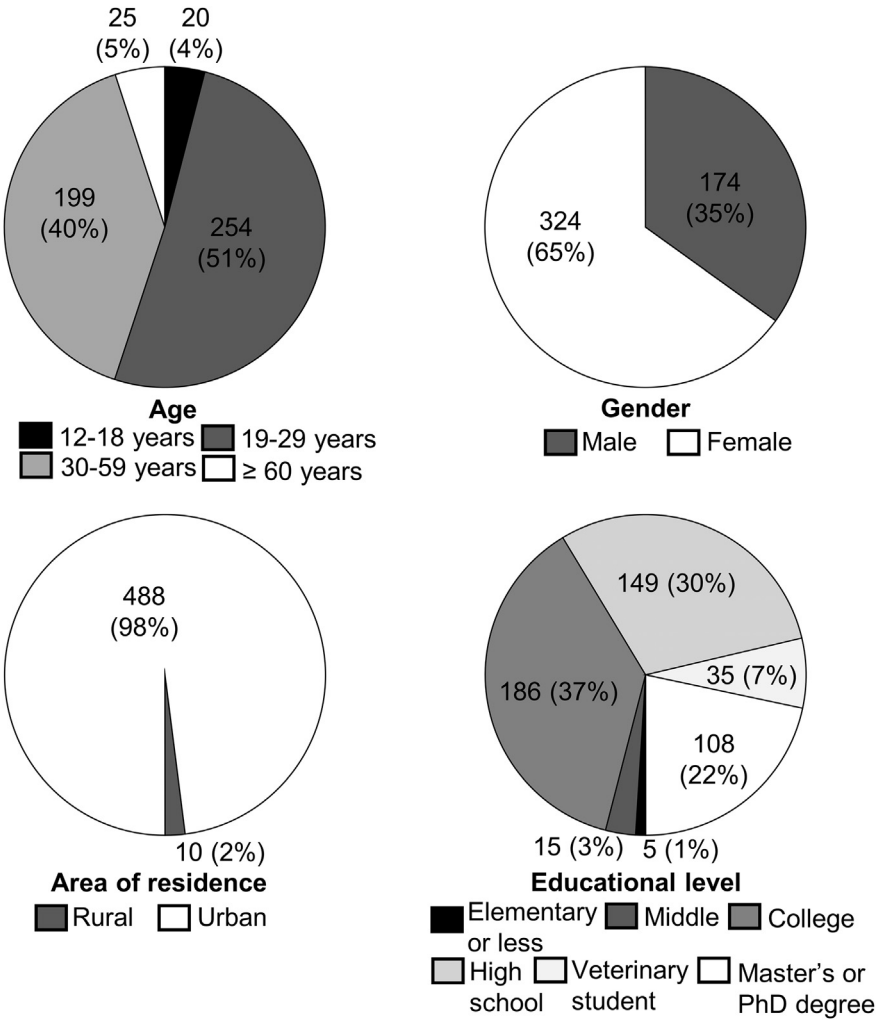

Fig. 2. Socio-demographic characteristics of 498 respondents on Brazilian territory between March and October 2017.

are about this group (i.e., 468 individuals who consumed milk or dairy products). The majority (98%) purchased dairy products from supermarkets, bakery or groceries store, and only 2% purchased on street markets or from a delivery man.

When asked about the meaning of "illegal milk and dairy products", about half of respondents (51%) stated awareness of these type of products, and most (54%) also consumed them (Fig. 3). Regarding the frequency of illegal milk and dairy products consumption, approximately 52% reported as rarely consuming, 38% sometimes and 10% regularly. The most purchased illegal product was fresh cheese (81%), followed by ripened cheese (32%) and fluid milk (24%), considering that more than one option could be marked. However, 92% of respondents who purchased raw milk indicated that they boiled the milk before consumption.

When asked the question "What is the reason for purchasing illegal milk and dairy products in an informal market", out of 468 respondents just one said they were the only option, while 6, 7 and 7, respectively, said they were more practical, reliable without frauds and more nutritive, 17 respondents said they were cheaper, and 54 said they were purer, without chemicals. Of the remainder, 154 gave other reasons and 222 responded that they were not consumers of illegal milk and dairy products.

The socio-demographic characteristics of unpasteurised milk consumers compared with the characteristics of those who did not consume unpasteurised milk had similar distributions (Fig. 3).

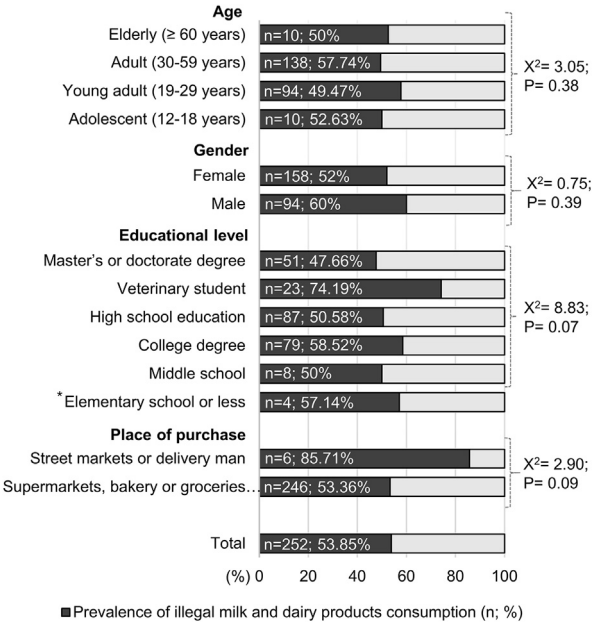

Fig. 3. Prevalence rates of illegal milk and dairy products consumption according with socio-demographic characteristics of consumers in Brazil, analysed by univariate chi-square (X^2) test (*observed frequency fewer than 5 was not analysed by Chi-square).

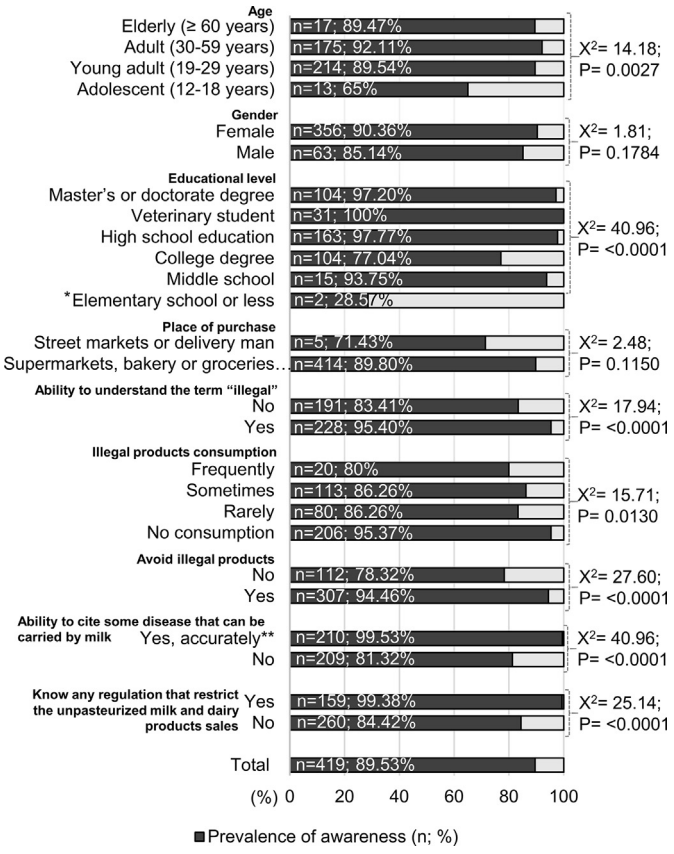

Fig. 4. Level of awareness of milk-borne infectious diseases according with socio-demographic characteristics of 468 consumers of milk and dairy products in Brazil, analysed by univariate chi-square (X^2) test (*observed frequency fewer than 5 was not analysed by Chi-square).

Based on the data collected, consumption of illegal milk and dairy products in Brazil occurs in all age groups, gender and levels of education. This situation occurs in urban area; 53% of urban population stated that they consume illegal milk and/or illegal dairy products. Almost 86% of consumers of illegal milk and/or dairy products stated purchasing them from street markets or from delivery man. Surprisingly, 66% (308) were not aware of regulations that prohibit the informal sale of uninspected milk and dairy products in Brazil.

Regarding the awareness of milk-borne diseases from consuming illegal milk and dairy products, the majority (90%; 419) were conscious about the risks (Fig. 4). Even respondents able to recognise the risks of contracting zoonotic pathogens, 16% (67) had a perception that illegal milk consumption was not harmful to health (this information was not tabulated and was provided by cross-tabulation of question 14 and 15).

Measuring the respondents' knowledge of diseases from consuming illegal milk, over half of respondents (52%; 245) stated knowing some disease that could be transmitted by illegal milk products consumption. When the respondents were asked to cite any disease, 45% correctly identified a disease. Among the correct answers, the most recurrent terms were brucellosis (62), food infection, food intoxication or toxicoinfection (46), salmonellosis or *Salmonella* (43), tuberculosis (39) and *Escherichia coli* (21). The rate for correct answers was higher in the group aware of milk-borne diseases, with 99% versus 81% (Fig. 4). It is also important to point out the inconsistency when comparing the agreement between the self-perception of knowledge with the answers classified as correct by the researchers. This lack of agreement ($p < 0.01$) was assessed by McNemar test and is shown in Table 1. For a person who declares to know some milk-borne disease, the probability to miss when asked to cite any one is 0.14. In other words, one out of every seven respondents who stated they knew of a disease was unable to cite one correctly. Our team classified as wrong answers that quote allergy, intolerance and other pathologies that were not associate with illegal milk and dairy products consumption, such as mastitis. Answers that quoted the etiologic agent rather than the pathology were classified as correct (e.g., *Brucella* rather than brucellosis).

Awareness of milk-borne zoonoses was not different between genders. However, the awareness of risks related to illegal milk and dairy consumption was lower among adolescents ($p < 0.01$); since 35% of the respondents between 12 and 18 years did not know the risks associated with consuming illegal milk. With advancing age, the awareness increased, around 90% after entering adult life (Fig. 4). The awareness was also associated with education ($p < 0.01$), with a significantly lower percentage ($p < 0.01$) of elementary school or less (29%) of the respondents being aware compared with respondents with higher educational levels (93%) (Fig. 4). Consumers who know the term "illegal milk and dairy products" were generally more aware about health risks associated with consuming unpasteurised milk (Fig. 4).

The prevalence of consumption of illegal milk and dairy products was lower among the consumers who were aware of milk-borne diseases, and of those, only five percent still consumed them and 95% avoided illegal products. On the other hand, the prevalence of consumption illegal milk and dairy products was more than three times higher (17%) among respondents who were not aware, and 88% of those avoided illegal products (Fig. 4).

Most consumers (99%) who were aware of milk-borne diseases stated knowing the illegal status of sales of unpasteurised milk and/or dairy for human consumption. This level of awareness was 15% lower (84%) among respondents who are not aware (Fig. 4).

Finally, when univariate logistic regression was applied to appraise if the awareness of milk-borne diseases can influence the chance of gastro-intestinal disorders, we found that consumers who are aware were, on average, twice as likely not to have abdominal pain or to have this symptom rarely (Table 2). In other words, the knowledge confers protection against abdominal pain.

Table 1
Rates for correct and incorrect answers of 468 consumers in Brazil regarding the diseases that can be carried by milk.[a]

Know some disease that can be carried by milk? (self-perception)	Ability to cite accurately a disease that can be carried by milk		
	No	Yes	Total
No	222 (47.44%)	1 (0.21%)	223 (47.65%)
Yes	35 (7.48%)	210 (44.87%)	245 (52.35%)
Total	257 (54.91%)	211 (45.09%)	468 (100%)

[a] The agreement between the self-perception of knowledge was compared with the answers classified as correct by our team, analysed by McNemar test (McNemar = 30.25; $p < 0.001$).

Table 2
Odds ratio (OR) and confidence interval (CI) of gastrointestinal disorders and hospitalisation associated with milk-borne disease awareness in 468 consumers of milk in Brazil.[a]

Condition	Frequency	B	S.E.	*P*	OR	95% CI
Vomiting	Never	5.39	824.81	0.99	219.13	0 − >1.00
	Rarely	5.24	824.81	0.99	189.09	0 − >1.00
	Sometimes	3.49	824.81	1.00	32.73	0 − >1.00
	Frequently	–	–	–	1.00	–
Diarrhoea	Never	0.57	0.41	0.16	1.77	0.79–3 0.99
	Rarely	0.20	0.37	0.60	1.22	0.58–2.54
	Sometimes	0.08	0.46	0.87	1.08	0.44–2.68
	Frequently	–	–	–	1.00	–
	Never	−1.18	1.10	0.24	0.31	0.04–2.23
Nausea	Never	−2.75	769.27	1.00	0.06	0 − >1.00
	Rarely	−3.82	769.27	1.00	0.02	0 − >1.00
	Sometimes	−2.50	769.27	1.00	0.08	0 − >1.00
	Frequently	−4.11	769.27	1.00	0.02	0 − >1.00
	Never	–	–	–	1.00	–
Abdominal pain	Never	0.68	0.35	0.05	1.97	1.00–3.89
	Rarely	0.82	0.34	0.02	2.26	1.16–4.43
	Sometimes	−0.15	0.35	0.67	0.86	0.43–1.73
	Frequently	–	–	–	1.00	–
	Never	−0.60	−0.93	0.52	0.55	0.09–3.42
Hospitalisation	No	0.06	0.17	0.71	1.07	0.76–1.49
	Yes	–	–	–	1.00	–
Last hospitalisation (months)	Cannot remember	−3.26	697.03	1.00	0.04	0 − >1.00
	Over 3	−3.63	697.03	1.00	0.03	0 − >1.00
	2 to 3	–	–	–	1.00	–
	1 to 2	3.42	697.03	1.00	0.03	0 − >1.00
	<1	−4.24	697.03	1.00	0.01	0 − >1.00

[a] Analysed by univariate logistic regression.

Others gastro-intestinal disorders (vomiting, diarrhoea and nausea) and hospitalisation were not associated with awareness.

4. Discussion

In this online survey, the response percentage cannot be calculated, as the number of people reading the advertising for participation is not known. Although this study improved upon previous research by using a national approach and by taking into account an epidemiological dimension, there were limitations that should be noted. First, the respondents do not reflect the total population of consumers in Brazil, as they were predominantly from urban areas (98%). Consequently, some factors related to rural population were not considered. Second, the fact that the present sample was from a higher educational level stratum than indicated by Brazilian census, which shows that over 92% of all internet users have more than 15 years of study (IBGE-SIDRA, 2016). Third, the tendency of eliciting a response from those who are searching on the internet for milk and milk related to topics, which implies that sporadic consumers are likely to be under-represented in this study. Thus, these sampling biases may have led to an underestimation of the frequency of gastro-intestinal disorders and an overestimation of the level of awareness, leading us to assume that our findings should be generalised with caution, but does not detract from the fact that the health status was linked to consumer's awareness about milk-borne disease.

The consumption of illegal milk and dairy products is very common in Brazil, with more than half of respondents (54%) still consuming them (Fig. 3). In contrast, in a population-based survey conducted in USA in 2003–2004 and 2005–2006, only less than 1% of respondents reported that they usually drank non-pasteurised milk (Langer et al., 2012).

Fig. 3 also presents the socio-demographic characteristics of illegal milk and dairy products consumers. The consumption is widespread across urban area, age groups, gender and level of education. Buzby et al. (2013) also found a similar gender and age distributions, but differently from our results, found that consumers who drank unpasteurised milk in USA were more likely to have lower incomes and less education.

As commented above, despite bans on the sale of uninspected and/or unpasteurised milk and dairy products for human consumption in Brazil, there are ways that consumers can obtain unpasteurised milk, such as street markets or via delivery man. However, a point that must be emphasised is the high frequency of purchase (53%) of illegal dairy products in legal markets, such as supermarkets, bakery or groceries store (Fig. 4). The market surveillance is conducted by Brazilian Health Regulatory Agency (Anvisa), and this situation poses a challenge to the national health system (Brasil, 2017).

Regarding the type of dairy product purchased, fresh cheese, ripened cheese and fluid milk were among the most popular illegal products consumed, all them with high rates of consumption. Specifically, fresh cheese and fluid milk pose the highest health risk of any type of illegal dairy products. As an example, a review of foodborne disease outbreaks involving dairy products over 13 years found that 33% of them involved cheese made from raw milk and 56% involved fluid raw milk (Langer et al., 2012). Fortunately, 92% of consumers stated that they boiled the illegal milk, which attenuates the seriousness of the risk posed (Tremonte, Tipaldi, & Succi, 2014).

The most common motivations behind consumption of illegal dairy products included purity (about 22% amongst consumers) and price (about 7%). Unfortunately, we were unable to determine which motivation factor was responsible for 63% of the answers, checked as “others” in the questionnaire. It is very likely, therefore, that it could be related to the taste, since many systematic reviews and original research listed the taste or the flavour of raw milk as primary factor for consuming it (Buzby et al., 2013; Raymundo et al., 2017; Waldman & Kerr, 2018). In addition, some socio-cultural aspects, such as regulatory history, cultural norms, socio-economic status, perception of health and risk, and even social justice, also contribute to individual and population preferences regarding raw milk consumption (Meunier-Goddik & Waite-Cusic, 2019).

Independently of the motivation, it should be stressed that consumers are receiving information and making decisions based

on non-scientific criteria and without consideration of safety and risk. In a recent study, about 17% of raw milk samples were positive for antibiotics residues and over 21% were found to be adulterated with water, which overturns the concept that illegal milk is purer and without chemical modifications (Ondieki, Ombui, & Obonyo, 2017). In fact, illegal dairy products are even more able to be adulterated, since they are not inspected by official control services.

The high rate (66%) of misinformation about restrictions on the sale of uninspected and or unpasteurised milk in Brazil is also alarming, since the regulation that restricts its sale has operated since 1952. Therefore, we cannot even discuss the morality of the consumer, because in this case, most people do not know that informal milk sale is illegal. It is important to point out that just one respondent said that illegal milk was its only source of purchase. Efforts should be directed to raise the public awareness and to strengthen control of informal sales.

If the population is not aware about restrictions on the sale of uninspected and unpasteurised milk on the one hand, they are conscious about the risks of contracting zoonotic pathogens on the other (about 90% are aware of risks) (Fig. 4). In a similar study conducted by Bassan et al. (2013) in Brazil, the level of awareness of milk-borne infectious diseases was lower (53%). In our study, the respondents were able to cite properly medical terminology for disease conditions, such as brucellosis, salmonellosis, tuberculosis, *E. coli*, food infection, food intoxication and toxicoinfection. Furthermore, the prevalence of consumption of illegal dairy products was lower among consumers who were aware of milk-borne diseases (Table 1). The results therefore suggest that it may be possible to decrease the consumption of these products by promoting knowledge to raise awareness of transmission of milk-borne diseases.

Conversely, even when aware of the risks, about 17% of the respondents were still consuming illegal dairy products (frequently or sometimes) (Fig. 4). So, the challenge is not only to increase the awareness, but to understand why the health risks are ignored by this segment of the population. It is important to note that the level of awareness of milk-borne diseases was not the same across age and educational level. So, educational efforts are even more worthwhile when targeted to adolescents and to people with only basic education.

Finally, and for the first time, the most valuable result showed that the milk-borne awareness can provide safety benefits for consumer health, being a protective factor against abdominal pain in consumers in Brazil (Table 2). It is well known that cross-sectional studies preclude causal conclusions, and to provide a better understanding of these issues, further researches with longitudinal or qualitative designs could be useful. Existing literature also finds a positive association between general knowledge and health status. Mosalagae, Pfukenyi, and Matope (2011) stated that by improving the level of awareness for zoonoses, teaching and training of population, both human health and food safety could be enhanced. In addition, Bell, Hillers, and Thomas (1999) also concluded that educational workshops were a successful food safety intervention to reduce the incidence of *Salmonella* Typhimurium associated with eating fresh cheese. This lead us to reinforce that knowledge can promote health-seeking behaviour and good health (Aaby, Friis, Christensen, Rowlands, & Maindal, 2017).

5. Conclusions

Although our results should be generalised with caution, findings reported here suggest that promoting knowledge to raise awareness of regulations and transmission of milk-borne diseases, mainly focused on teenagers and people with low educational level, could decrease the prevalence of consumption of illegal dairy products.

We found, to the best of our knowledge, the first relationship between the awareness of milk-borne diseases with the epidemiology of gastro-intestinal disorders, leading us to conclude that the ability to understand the risks of unpasteurised dairy products consumption were associated with health status of the population.

Acknowledgements

The authors acknowledge the Fundação Nacional de Desenvolvimento do Ensino Superior Particular (FUNADESP) for financial support.

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