



Effect of raw milk consumption on perceived health, mood and immune functioning among US adults with a poor and normal health: A retrospective questionnaire based study



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ABSTRACT

Introduction: Raw milk consumption is controversially discussed, and people are looking for raw milk due to expected positive health impacts. The purpose of this consumer survey was to evaluate health conditions prior to and after consuming of raw milk (RM).

Methods: An on-line survey was distributed in Spring 2018 among existing consumers of raw milk. One-Item health score, 1-item immunity score, immune status (ISQ), mood, bowel and skin conditions were rated retrospectively based on validated questionnaires. Data from 327 participants (age 54 years) were included, of which 156 (48%) were allocated to the poor health group after they reported being immune depressed or suffering from a chronic disease. Others were allocated to the normal health group. Milk consumption pattern before and after changing of the milk diet were recorded. All health outcomes were evaluated according a linear mixed model in SPSS.

Results: Health, perceived immunity, bowel and mood scores increased post RM consumption with around 35% in the poor health group ($P < 0.001$), and around 9% in the normal health group ($P < 0.001$). Bowel and mood scores were overall lower in women than in men. Outcomes were independent of the origin of raw farm milk.

Conclusions: This consumer survey suggests that positive health and mood changes are associated with the consumption of raw milk. Effects were strongest in people with a self-reported poor health status as well as in women.

1. Introduction

Since man domesticated ruminating animals 8–10,000 years ago, people started consuming milk and fermented milk products. Over time, several DNA mutations on lactase persistency gave herders and people with a Caucasian background the ability to digest lactose in sweet unfermented milk after weaning.¹² Obligated pasteurization of fresh milk started in the early to mid part of the 20th Century,³ but in earlier centuries most milk and its products were consumed raw. Today there is a lot of debate about the effects of consumption of dairy products on health.⁴ Studies contradict each other depending on the type of dairy product, gender effects or the inclusion of fermented milk products,⁵⁶ the region of production,⁷ or the origin of dairy products (catchwords:

grass milk, organic milk, hay milk, antibiotic-free milk, A2 milk),^{8,910} Also the impact of heating was discussed in relation to the health status of French people.¹¹ Besides the unheated status of fresh milk, also the content of saturated fat, the fatty acid quality and the trans-fats in milk were questioned.^{7,12,13,14}

The consumption of raw milk or raw milk products has been negatively impacted by zoonotic disease outbreaks.^{15,16} However, the number of outbreaks has been shown to be decreasing in USA.¹⁷ Raw milk is a consistent niche market in which people consciously opt for this type of product because of taste or health.^{16,18,19,20} An increasing group of people are consuming raw milk to contribute to their healthy life style.^{16,21} A wide range of epidemiological studies have shown positive health effects such as that early-life consumption of raw milk

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was associated with reduced risk of asthma, hay fever and allergies.²² The consumption of raw milk is seen as an independent, single protective factor for immune related diseases in young children.²³ If raw milk is heated (> 80 °C), then its protective qualities are lost.²⁴ Epidemiological results in children were confirmed in animal studies for allergies and asthma.^{25,26}

1.1. Goal

In a study in The Netherlands changes in self-reported health and mood after the consumption of raw fermented kefir were shown. Customers of raw fermented milk products experienced an improved health especially those with reduced immunity or chronic health problems.²⁷ This study focuses on the self-reported changes in health and mood following the consumption of raw milk dairy among US citizens. It is therefore hypothesized that the current study will show that switching to raw milk consumption is associated with positive perceived health and mood effects.

2. Material and methods

To gain insight in the changes in health after raw milk consumption a questionnaire was prepared. The evaluation of ones own health is a low-threshold method to estimate environmental, nutritional effects or the lifestyle of people.^{28,29}

A study was conducted among current US raw milk (RM) consumers to evaluate their perceived health and mood prior and after the start of consuming RM. Subjects were recruited through Internet announcement from the Raw Milk Institute (RAWMI) listed farmers. Subjects were invited to complete an online survey, designed with Survey Monkey (www.surveymonkey.com). Subjects were included if they were at least 18 years old and started consuming RM dairy more than 2 months ago. Informed consent was obtained from all participants, and ethical approval was granted by the Ethics Committee of the Faculty of Social and Behavioral Sciences of Utrecht University, Utrecht, The Netherlands. The study was conducted over 10 weeks in the spring of 2018.

2.1. Subjects

Information on age, height, weight, gender and whether they live in a rural or urban environment was collected. Subjects were asked if prior to starting consuming RM they were suffering from chronic disease and/or reduced perceived immune functioning. If subjects answered positively in at least one of the two questions, they were allocated to the poor health group, and otherwise allocated to the normal health group. There were 762 returned questionnaires, of which 380 were complete. Subjects were included who indicated not to consume any raw milk products prior RM. Subjects with extremely high values for dairy consumption (milk consumption ≥ 3 SD from mean) were excluded for the further analysis. The final dataset consisted of 327 subjects (see Table 1).

2.2. Dairy consumption

Dairy consumption was assessed both before and after switching to RM. Before switching to RM, daily intake of pasteurized milk (200 ml servings), fermented milk (200 ml servings), cheese (portion 50 g), and butter (portion 15 g) was recorded. After switching to RM, daily intake of raw fermented drinkable milk (200 ml servings), raw milk butter (portion 50 g), and raw milk cheese (portion 50 g) was recorded. Subjects indicated the farm source of the raw milk.

2.3. Perceived immune functioning and health

Perceived immune functioning was assessed with a scale ranging

from 0 (very poor) to 10 (excellent).²⁸ Using a comparable 11-point scale, perceived overall health was assessed. Significant correlations of 1-item perceived immune functioning and health scores with mental resilience,²⁸ autism traits,³⁰ and the Immune Function Questionnaire were found.²⁸

2.4. General immune status

To assess the immune status, the Immune Status Questionnaire (ISQ) was completed.²⁹ The ISQ consists of 7 items, including common cold, diarrhea, sudden high fever, headache, muscle and joint pain, skin problems and coughing. The items were scored on a 5-level Likert scale stating how often the subjects experienced these complaints.³¹ The range used is from 0 (never), 1 (sometimes), 2 (regularly), 3 (often), to 4 ((almost) always) and the sum score is calculated. The overall ISQ score ranges from 0 (excellent) to 28 (very poor).

2.5. Gastro-intestinal conditions: diarrhea and constipation

Gastro-intestinal health questions were based on 10 of 11 questions from the Birmingham Irritable Bowel Syndrome Questionnaire (IBS).³² Diarrhea items included leaking or soiling body, feeling to immediately rush to the toilet to pass stool, troubled with loose or watery stool and troubled with diarrhea. A 5-level Likert scale from 1 (extremely) to 5 (not at all) was used to answer the questions. The sum of the Likert scores was used as an outcome variable in the statistical analysis. The diarrhea score was based on 4 items (range 4–20), with higher scores indicating less diarrhea disease problems.

Constipation items included pain or discomfort in abdomen, trouble with hard bowel movements, needing to strain to pass a bowel movement, trouble with constipation, pain or discomfort in abdomen after eating, abdominal pain preventing sleeping or waking up during the night. The constipation score was based on the sum of the 6 items (range 5–30) with higher scores indicating less constipation problems.

2.6. Skin conditions

The questions were based on 10 of 11 questions from the Dermatology Life Quality Index (DLQI) Questionnaire.³³ The skin score assessed skin conditions: itchy, sore, painful or stinging skin, skin embarrassment or self-consciousness, skin interference with shopping or gardening, skin influencing wearing clothes, skin affecting social or leisure activities, skin interference with any sport, skin influencing work or studying, skin creating problems with partner or close friends, skin treatment making home messy or taking up time. A 5-level Likert scale from 1 (extremely) to 5 (not at all) was used to answer the questions. The sum of the Likert scores was used as an outcome variable in the statistical analysis. The overall skin score was based on ten items (range 10–50), with higher scores indicating a better skin status.

2.7. Mood

The questions were based on the Profile of Mood Status (POMS) scale that describes the psychological distress of people.³⁴ Five mood items included the level of fatigue, level of tension/anxiety, level of depression or dejection, level of anger or hostility and the level of vigor or activity. A 5-level Likert scale from 1 (extremely) to 5 (not at all) was used to answer the questions. The sum of the Likert scores was used as an outcome variable in the statistical analysis. The overall mood score was based on four items (range 5–25), with higher scores indicating a better mood.

2.8. Statistical analysis

All statistical analysis was conducted with SPSS, version 20. Mean and standard deviation (SD) were computed for each outcome variable.

Table 1

Background Information of the Study Population and the Milk Consumption before and after Switching to Raw Milk (n = 327).

	Mean \pm SD	P-value			
Feature			Health status	Gender	Living location
Age (years)	53.9 \pm 13.1	0.832		0.089	0.012
BMI (kg/m ²)	25.5 \pm 5.2	0.203		0.293	0.612
RM products since (year)	2008.2 \pm 10.4	0.001		0.352	0.239
Pasteurized milk prior RM:					
Milk ^b	4.4 \pm 4.8	0.180		0.429	0.233
Fermented milk products ^b	0.9 \pm 1.9	0.555		0.274	0.692
Yoghurt ^b	1.8 \pm 1.9	0.458		0.251	0.764
Cheese ^c	8.5 \pm 7.3	0.554		0.136	0.148
Butter ^d	7.7 \pm 6.6	0.807		0.893	0.717
Raw milk products post RM:					
Raw Milk ^b	8.2 \pm 8.1	0.667		0.982	0.225
RM Kefir ^b	1.9 \pm 3.1	0.159		0.991	0.113
RM Cheese ^c	5.9 \pm 7.0	0.593		0.475	0.278
RM Butter ^d	6.7 \pm 7.8	0.214		0.075	0.419

^a Mean \pm SD and the level of significance for the four main factors: health status, gender, living location and raw milk origin based on a General Linear Model. Two-factorial interactions were not significant and are not shown. Differences are statistically significant if $p < .05$.

^b (200 ml servings).

^c (portion 50 g).

^d (portion 15 g). Abbreviations: RM = raw milk, BMI = body mass index.

Level of significance was set at $\alpha = 0.05$ for all analysis.

For the statistical analysis of the demographic information and dairy consumption, a Univariate General linear Model (GLM) was made based on the factors 'health status' (poor health and normal health group), 'gender' (men and women), 'location of living' (urban and rural) and 'raw milk origin' (Organic Pastures, other farms, own farm) and their two-way interactions of the four factors.

To evaluate the health outcomes a linear mixed model was used including the factors 'RM-time' (prior RM and post RM), 'health status', 'gender', 'location of living' and 'raw milk origin'. In the mixed model participants were taken as subjects and RM-time was used as a repeated measure. The covariance in the model was analyzed according the scaled identity. As fixed factors in the model health status, RM-time, gender, location and raw milk origin and their two-way interactions were integrated in the model. A two-step transformation to normality was done for all health outcome sum scores to correct for the skewness of the data.³⁵

3. Results

3.1. Demographic characteristics and dairy consumption pattern

Subjects suffering from a chronic illness were asked to list them. A total of 288 complaints were mentioned, and single subjects could mention more than one complaint. About 32% of the health problems were related to inflammation and immunity problems, followed by problems with digestion and bowel (22%).

The average age of the research population was 53.9 years. Of these

327 subjects, 68.8% were women, people with a reduced immunity and/or poor health were 47.7%, and 73.7% lived in an urban environment. Regarding the raw milk origin 47.1% bought milk from Organic Pastures (California), 41.9% from other raw milk producers and 11.0% milk from their own farm. On average people consumed raw milk since 2008.

There were no relevant significant differences in consumption patterns (See Table 1). Subjects with a poor health status started 4 years later with RM consumption than subjects with a normal health status (2010.2 \pm 5.8 versus 2006.3 \pm 13.0). Rural living subjects were around 4 years older than urban living subjects (56.8 \pm 14.1 versus 52.5 \pm 12.5), subjects consuming raw milk from their own farm also ate most RM butter post RM (respectively 5.7 \pm 6.2, 6.8 \pm 8.3 and 10.2 \pm 9.9 for Organic Pastures, other farms, and own farm). There were no significant interactions, except for gender x raw milk origin for age ($P = 0.017$) and RM butter post RM ($P = 0.002$). Post RM, subjects consumed mostly sweet, fresh RM (8.2 cups of 200 ml per week). On average the amount of raw milk consumed via RM cheese is 1.5 cups, which means, that subjects consumed additionally to fresh RM another 3.4 cups of fermented RM products per week.

3.2. Health outcomes

Starting RM consumption had significant positive effects on health outcomes (Table 2 and 3). Two factors were highly significant for most outcomes: the factor RM time ($P < 0.001$) and health status ($P < 0.001$ except for Diarrhea ($P = 0.033$) and Skin problems ($P = 0.005$)), but also all their interactions (Health status x Raw Milk

Table 2Health Scores and Mood Before and After Changing to RM According to Health Status ^a.

Health status	Poor health group			Normal health group		
n	156			171		
Time RM	Prior RM	Post RM	P-value	Prior RM	Post RM	P-Value
Perceived health	5.4 \pm 2.1	8.4 \pm 1.4	< .001	7.9 \pm 1.6	8.9 \pm 1.2	< .001
Perceived immune functioning	5.0 \pm 2.2	8.5 \pm 1.4	< .001	8.0 \pm 1.6	9.1 \pm 1.1	< .001
Immune Status Questionnaire	8.3 \pm 4.2	2.5 \pm 2.0	< .001	4.3 \pm 2.9	2.1 \pm 2.1	< .001
Constipation	20.4 \pm 5.5	27.6 \pm 2.3	< .001	25.3 \pm 3.9	28.0 \pm 2.5	< .001
Diarrhea	16.1 \pm 3.2	18.8 \pm 1.6	< .001	17.7 \pm 1.9	18.7 \pm 2.0	.001
Skin	38.7 \pm 8.0	43.6 \pm 3.1	< .001	43.2 \pm 3.8	44.2 \pm 2.2	< .001
Mood	15.1 \pm 3.6	19.6 \pm 2.5	< .001	18.2 \pm 3.3	19.9 \pm 2.9	< .001

^a Mean \pm SD and level of significance in the poor health group and the normal health group based on a Linear Mixed Model. Interactions between health status and RM time are not significant and not shown. Differences are statistically significant if $p < .05$.

Table 3
Health Scores and Mood Before and After Changing to RM According to Gender in the Poor Health Group (above) and the Normal Health Group (below) ^a.

Poor health group						
Gender	Men			Women		
n	41			115		
Time RM	Prior RM	Post RM	P-value	Prior RM	Post RM	P-value
Perceived health	5.5 ± 2.1	8.5 ± 1.2	< .001	5.4 ± 2.1	8.3 ± 1.5	< .001
Perceived immune functioning	5.1 ± 2.2	8.6 ± 1.4	< .001	5.0 ± 2.2	8.5 ± 1.5	< .001
Immune Status Questionnaire	7.6 ± 4.1	2.3 ± 2.0	< .001	8.5 ± 4.2	2.5 ± 2.1	< .001
Constipation	22.9 ± 4.5	28.2 ± 2.9	< .001	19.5 ± 5.6	27.4 ± 2.4	< .001
Diarrhea	16.6 ± 2.2	18.9 ± 1.4	< .001	16.0 ± 3.5	18.7 ± 1.7	< .001
Skin	41.3 ± 5.9	44.2 ± 1.8	.001	37.8 ± 8.4	43.3 ± 3.5	.002
Mood	16.4 ± 3.9	20.0 ± 2.4	< .001	14.6 ± 3.5	19.5 ± 2.6	< .001
Normal health group						
Gender	Men			Women		
n	61			110		
Time RM	Prior RM	Post RM	P-value	Prior RM	Post RM	P-value
Perceived health	8.2 ± 1.6	8.9 ± 1.4	.009	7.8 ± 1.6	8.9 ± 1.1	< .001
Perceived immune functioning	8.2 ± 1.4	9.0 ± 1.2	.004	7.9 ± 1.7	9.1 ± 1.1	< .001
Immune Status Questionnaire	4.2 ± 3.3	2.1 ± 2.5	< .001	4.4 ± 2.7	2.7 ± 2.1	< .001
Constipation	26.7 ± 2.6	27.9 ± 3.0	< .001	24.5 ± 4.2	28.0 ± 2.3	< .001
Diarrhea	17.6 ± 1.7	18.3 ± 2.8	< .001	17.7 ± 2.1	18.9 ± 1.3	< .001
Skin	42.4 ± 5.6	43.8 ± 3.4	.003	43.6 ± 2.2	44.4 ± 1.2	.008
Mood	18.6 ± 3.6	20.0 ± 3.2	< .001	17.9 ± 3.1	19.8 ± 2.7	< .001

^a Mean ± SD and level of significance in men and women with either a poor health (above) or a normal health (below) based on a Linear Mixed Model. Interactions are not significant and not shown. Differences are statistically significant if $p < .05$.

Time), (all $P < 0.001$). Results are therefore presented for each of the health group separately (poor health and normal health).

For the split results the largest impact remained from RM Time (Table 2). For all health outcome scores, subjects improved their score post RM compared to prior RM. The absolute change in health improvement was significantly greater in the poor health group compared to the normal health group.

For the factor gender there were a limited number of significant outcomes (Table 3). The largest impact was on the constipation problems between men and women in both the poor and the normal health group. Several other scores were significant in the normal health group, but the absolute differences between men and women remained small. The living location was not significant in any of the items for both the poor health and the normal health groups. The raw milk origin was not significant in the normal health group. In the poor health group, subjects drinking their own farm milk mentioned a lower ISQ ($P = 0.028$), indicating a better immunity. The diarrhea score was lowest in subjects consuming raw milk from other farms ($P = 0.011$).

4. Discussion

In a retrospective on-line survey mature adults evaluated their health impact after changing their milk diet from pasteurized milk and milk products to raw milk and milk products. The largest amount of fluid dairy consumption consisted of raw milk (8.2 servings of 200 ml/week), but also raw milk kefir, raw milk butter and raw milk cheese were consumed post RM. The background of the subjects was controlled for 5 factors: RM time, health status, gender, living location and the origin of the raw milk. Subjects with a poor health status reported the biggest health and mood benefits from changing to RM consumption. However, albeit of a lesser magnitude, also the health and mood status of healthy subjects improved by switching to RM consumption. There was no effect of living location or source of raw milk on the health improvements indicating that that any raw milk affected the changes in health. There was a moderate effect of gender, and women showed more complaints than men prior RM. Post RM women showed a stronger health improvement than men and differences between gender were reduced post RM.

The correlation between raw milk consumption and the reduction of immune related diseases, like asthma, allergies and hay fever has been

established in young children in different countries.³⁶ As a protective effect, early life raw milk consumption was found as a single protective factor, also in non-farm children. These epidemiological human studies were confirmed in experimental animal studies. In a case control study using 5-week-old mice, raw milk did not show any signs of asthma in contrast to raw milk heated at 80 °C.²⁵ The same was seen for milk allergies both in a small group of children (age 1.5 years) and mice.²⁶ In this study, after heating of raw milk young mice showed typical milk allergic immunological response (anaphylactic shock, wheel building after skin prick and temperature drop).

In contrast, in the current study mature adults (average age 54 years) evaluated their perceived health effects after the switch to raw milk consumption. The mechanism of protection might be different compared to the studies in young mammals, with developing immune systems. The reason for why raw milk improved the health outcomes in adults may be due to changes in the structure and functioning of the gut flora as well as the integrity of the gut wall. In the relationship between raw milk and health, a differentiation should therefore be made between preventive and potential curing effects of raw milk. Unfortunately, in the current retrospective study no causality can be demonstrated. In a prospective future study, biomarkers of immune fitness (e.g., cytokines) and microbiome flora should be assessed before and after switching to RM consumption to demonstrate this causality.

In another study in The Netherlands the consumption of raw fermented drinkable milk products (raw milk kefir and raw milk yoghurt) was evaluated. The study showed almost identical positive health effects after changing to RFM products.²⁷ Subjects with a suppressed health and immunity, and especially in women, improved their health status more after the consumption of drinkable raw fermented milk products. The largest difference between the US and Dutch adults was in the poor health group. US adults were even more negative about their health prior RM, but they showed an increased improvement in health post RM compared with the Dutch adults. By comparison to raw milk, raw fermented milk is a rich source of living bacteria.³⁷ The common characteristic in both research populations is the consumption of raw, non-pasteurized milk. Experimental studies on the impact of non-heated, raw milk are missing and this study is one of the first retrospective studies that showed an impact on several health aspects in adult subjects. More clinical studies in this research area are therefore needed.

4.1. Raw milk safety

The consumption of raw milk is not recommended from health officials.¹⁵ Specific groups in the society like the elderly people with a weakened immune system, young children and pregnant women (the unborn child) are recommended not to consume any raw milk or raw milk products. In the different states within the US the regulation for raw milk sales ranges from a complete ban to an open market. For the US, the trends in foodborne illnesses from 2005 onwards were analysed,¹⁷ and since 2010, there has been a steady reduction of raw-milk outbreaks, although the consumption of raw milk has increased. Knowledge about safe raw milk production has improved over the last decade and raw milk farmers are now producing hygienic raw milk of a quality close in safety to pasteurized milk.¹⁷ The outcome of the underlying study is based on raw milk producers that strictly control their raw milk safety and zoonotic dangers. In the light of the current beneficial effects not only shown for children but also perceived by adults a proper risk benefit analysis need to be performed.

4.2. Limitations

The present study has several limitations. The major limitation of this study is the fact that only current consumers of RM were included. As they are current customers this suggests that this group is satisfied with the experienced effects of RM products. It is likely that customers that did not experience a positive health effect after switching RM products returned to using conventional pasteurized milk products. To confirm the current self-reported positive health effects, future studies should therefore have a prospective design following customers from the moment they switched to RM. That way, the actual percentage of customers that experienced positive health effects from switching to RM can be determined, and these customers can be directly compared to subjects that not experienced positive health effects. Bias further arises because subjects may already have an expectation when purchasing the product and therefore assume that the product will have a positive effect on their health. A double-blind experiment comparing RM to regular, pasteurized milk would provide insights in to what extent expectations play a role in perceived health effects after switching to RM. Finally, the study is retrospective, which means that recall bias may have played a role. The time since switching to RM products varied significantly across subjects and may have had an impact on what and how specific health and mood states may be recalled and perceived. Taken together, the results of the current study should therefore be seen as preliminary and confirmed in future prospective or experimental studies.

5. Conclusions

- Based on a retrospective study of 327 mature adults, it becomes clear that the largest improvements of the conversion towards raw milk (8.2 servings per week) and several raw milk products (3.4 servings per week) is found in subjects suffering from chronic health problems or mentioning problems with their immunity (poor health group). The impact of people's health status is affecting the outcomes more than their gender, whereas no impact is found from the place of living or the raw milk origin. This implies that any type of raw milk in this study had the same outcome.

- Subjects indicating a poor immunity or suffering a chronic disease (poor health group) mentioned a larger improvement of around 35% in all measured areas of health and mood than those who did not report any problems (normal health group), around 9%. Differences in all measured areas of health between people with poor health and normal health became smaller post RM.

- There are differences between men and women in the study population. Men had fewer problems than women prior RM, but women mentioned larger improvements in their health than men. Differences in

health score between men and women post RM disappeared.

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Declaration of Competing Interest

Ton Baars and Catharina Berge were board members of the Raw Milk Institute, California till December 2018. Ton Baars is advisor of the German Vorzugsmilch-Verband. Johan Garssen is part time employee of Nutricia-research.

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