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Systematic Review

Public Health Threat with Consumption of Unpasteurized Milk: Systematic Review

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ABSTRACT

Unpasteurized milk consumption is common throughout the globe, despite the negative consequence for consumer health. This review paper identified public health risks resulting from unpasteurized milk. Several keywords were used to search online, including Google Scholar, PubMed, Science Direct, and academic publications. Significant data were rigorously extracted and reported as per the PRISMA statement guideline. Individuals' risk from consuming raw milk was examined in 15 studies. According to a laboratory investigation report, raw milk contained several parasites and harmful bacteria in unpasteurized milk. These include campylobacteriosis, brucellosis, Staphylococcus aureus, streptococcus, salmonellosis, E. coli 0157, and other hazardous poisons like Aflatoxin M1. People are exposed to pathogenic microorganisms, parasites, and other dangerous toxic agents while consuming raw milk. Therefore, ensuring the safety and quality of raw milk through implementing hazard-critical control points during production and distribution is mandatory in the dairy industry to safeguard general public health.

INTRODUCTION

Milk pasteurization is a process of heating on the standard temperature pressure to kill pathogens, which present in raw milk and improve its quality [1]. Proponents of milk products provide noticeable health benefits with a strong bone structure and teeth and prevent certain chronic health illnesses such as allergy, obesity, high blood pressure, and type 2 diabetes [2]. Communities in the world take milk from a variety of animals' source including; goats,

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sheep, cows, and camels; these might be different from one country to another based on religious and cultural ground [3]. Certain nutrients and mineral contents in milk provided for a human to acquire extraordinary good health conditions, including; *calcium, phosphorus, Riboflavin (B2), vitamin B12, potassium, vitamin A, zinc, and Magnesium* [4-6]. Unfortunately, raw milk consumption could potentially cause several diseases for consumers. Since, milk and its products are the kind of perishable food that holds many essential nutrients, which is sensitive to microbial (pathogenic organisms) [7-8]. Some diseases are contagious diseases that spread out from animals to humans. It is estimated that approximately 75% of recently emerging infectious diseases, that affect human diseases were of animal origin; approximately 60% of all human pathogens are zoonotic [9-10]. Potential risk factors were milk handlers and animal's health conditions because, people exposed with certain pathogen via of direct contact with infected animals [1,11]. In many countries milk born outbreak were reported [12] and identified factors including milk handling, knowledge and environmental condition [9,13]. Safety and hygiene of milk problems were majorly affected due to lack of policy implementation, and inadequate infrastructure (agro-processing). which were key issues exacerbating risk to their health [6,14,15]. As evidence suggested that, milk borne disease mainly caused by consuming unprocessed milk [4,16-19,19]. Ideally, ordinary people believed that drinking milk as a raw condition saved nutritional value, which overlooking its safety and hygienic condition [20-23]. Studies showed that young and elders, pregnant women, and chronic and complicated health illness individuals are highly risk groups for zoonotic disease [1,3,19,24], this was confirmed that their level of immunity systems and other dietary pattern. For example, milk products, such as cream, cheese, and yogurt can be easily contaminated with harmful bacteria and cause serious infections, including *Brucellosis, Campylobacteriosis, E. coli 0157:H, Salmonella, and Toxoplasmosis*. Unlikely, certain microbes such as *Staphylococcus aureus and E. coli 0157:H7* are present in human and animal health, but cause serious illness and death occurs unless taken any medical treatment [25].

Milk borne disease

Brucellosis

Brucella is a bacterial microbe that originates in unpasteurized dairy products. *Brucella* infection, or Brucellosis, has also been called "Undulant Fever" because of the regular recurrence of fever associated with the disease. It is one of the possible causes of lengthy fever with unknown origin in children [9,26,27].

Campylobacteriosis

The bacteria are typically detected in the feces of infected animals and food products that have come into contact with the germs during processing or preparation. One of the main causes of human infection is consuming unpasteurized milk. *Campylobacter spp.*, including *C. jejuni* and *C. coli*, are the leading causes of enteritis in humans. Patient with disease may experience symptoms such as diarrhea, fever, nausea, vomiting, headaches, and muscle discomfort [13].

Cryptosporidiosis

A coccidian parasite is known as *Cryptosporidium species*, which is carried by infected animals. People may expose with the disease due to consumption of unpasteurized milk and poor hand hygiene. Symptoms such as stomach pain, watery diarrhea, nausea, lack of appetite, vomiting, fever, and muscle pain were common [12,25,28].

Escherichia coli 0157:H7 (E. coli) infection

Escherichia coli (E. coli) are a group of bacteria that inhabit the digestive tracts of both humans and animals. While majority of *Escherichia coli* are a natural component of the intestinal flora, some serotypes, like *E. coli 0157:H7* can cause intestinal disease (food poisoning) in humans, resulting in bloody diarrhea, hemolytic uremic syndrome (HUS), kidney failure [1,14,19,29].

Listeriosis

Listeria monocytogenes are bacterial disease that attacks ruminants and humans. It is excreted via feces. Unlike other bacteria, people who touch sick animals might be at risk of getting the disease. Pregnant women and immune-suppressed individuals need to refuse to consume unpasteurized dairy products [3,30].

Salmonella

Salmonellosis is a bacterial pathogen that is well-known for causing food-borne illnesses in humans. It is transmitted through eating and drinking improper or undercooked foods such as unpasteurized milk and dairy products, meat, eggs, and other animal products. Diseases with *salmonellosis* were including, feel abdominal discomfort, headache, fever, and diarrhea [19,31].

Sarcocystosis

The parasitic protozoan species known as *Sarcocystis* are found in unpasteurized milk. People got the disease through ingestion of the protozoan, most frequently undercooked and unsafe storage of animal products. Muscle tightness or painful swelling, weakness, headache, coughing, and temporary itching and rashes were some of the symptoms of the *sarcocystosis*-related disease, and symptoms such as fever, chills, sweating, chills, abdominal pain, diarrhea, nausea, and vomiting [25,28,32].

Toxoplasmosis

Toxoplasma gondii is a tiny protozoan parasite that causes severe human disease. Individuals may manifest in the symptoms such as fever, body aches, headaches, and sore

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throats). It is causing a dangerous condition for women during baby carriage [33,34].

Control of milk-born disease

Raw milk is the most known for perishability and cause serious disease for consumers unless keep and follow safety protocol, which is recommended by the world health organization including; Hazard Analysis Critical Control Point (HACCP) and other quality cheek parameters to control against physical, chemical and biological hazard [7,20,22]. Implementing adequate control strategies assures quality and safe milk production through pasteurization and "Test and Hold" programs [6,14].

METHODS

This systematic review paper was developed using PRISM guideline [35]. Different searching electronic data based were used; these included Google Scholar, PubMed, Science Direct, and other academic papers from different university depository to identify the relevant papers on public health threats with consumption of unpasteurized milk. In addition, keywords such as "foodborne", "Milk borne", "Raw milk", "unpasteurized milk", "consumption" "children", "elder ", "women", "Human health", "risk factors", "milk handling", "milk-borne outbreak", and "prevention and control" were used and connected by using "OR" and "AND" to find more relevant papers, Furthermore, different studies were found out through cited reference list from all research papers. To develop this systematic review paper, pertinent studies were gathered. Experimental and epidemiologic investigations were included. Studies published in 2008–2022 reported pathogens related to the consumption of unpasteurized milk were addressed. Studies that were conducted before 2008 and investigated qualitatively were excluded from the review. Moreover, the corresponding authors were contacted through email whenever there were no full text available, and unanswered emails were excluded from the study. The outcome of the study was an isolated pathogen in raw milk and its effects on human health. Systematically data was extracted from the paper pre-designed format in the table and exported to all papers in the Medline reference database. The extraction process was adapted from the Joanna Briggs Institute (JBI) extraction format [36]. Relevant information was compiled in Microsoft Excel sheets by author and year, sample size, study design, region, milk-borne disease, and handling practice. The extracted format was developed based on the systematic objective of this study, and all authors participated to review independently the full text whenever disagreement happens between us resolved through discussion. The assessment of methodological quality, comparability, and outcome of each study was reviewed by all authors independently and using Newcastle Ottawa Scale (NOS) quality assessment protocol for a cross-sectional study [37].

RESULTS

This systematic review paper addressed the public health threat of consuming unpasteurized milk, and its implication to prevent milk-borne disease. Fifteen studies systematically identified and extracted valuable information regarding topic desire. The overall undertaken procedure performed to reach the final eligible paper was showed below in Fig1.

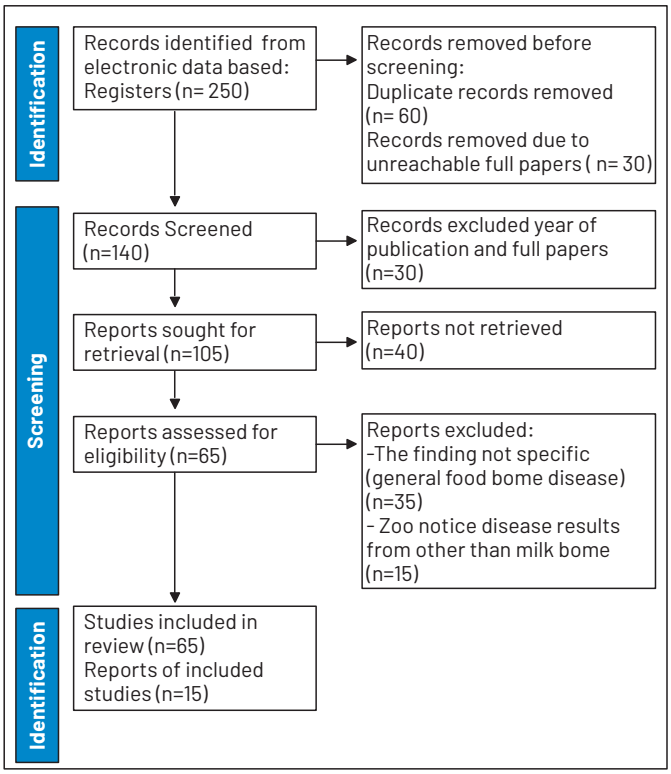

Figure 1: Flow diagram of the existing milk-borne disease studies related to a public health threat

Characteristics of reviewed studies

This paper included fifteen pieces of research that were done in various nations throughout the world and released in late 2008. Most of the included studies were experimental or observational. As per researcher reports, the study tried to analyze their findings and forward the message regarding the public health threat of consuming unpasteurized milk Table 1.

Author	Country	Study type	Study design	Publication status
[13]	Italy	Quantitative	Cross-sectional	Published
[38]	Iowa	Observational	Prospective cohort	Published
[9]	Iran	Quantitative	Cross-sectional	Published
[16]	Nigeria	Experimental	Cross-sectional	published
[1]	Ethiopia	Experimental	Cross-sectional	Published
[10]	Ethiopia	Observational	Cross-sectional	Published
[19]	Egypt	Experimental	Cross-sectional	Published
[14]	Finland	Experimental	Cross-sectional	Published

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Author	Country	Study type	Study design	Publication status
[14]	Uganda	Quantitative	Cross-sectional	Published
[33]	Pakistan	Experimental	Case-Control	Published
[39]	Italy	Experimental	Cross-sectional	Published
[26]	Israel	Experimental	Cross-sectional	published
[27]	Iran	Quantitative	Case-control	Published
[31]	Serbia	Quantitative	Retrospective	Published
[29]	Egypt	Experimental	Cross-sectional	Published

Table 1: Included reviewed papers for public health threats with consumption of unpasteurized milk

The common milk-borne diseases reported by researchers included: *campylobacteriosis*, *brucellosis*, *TB*, *Toxoplasmosis Gondi*, *Klebsiella*, *E. coli 0175*, *Pneumonia*, *Staphylococcus aureus and Salmonella species*. Other studies also investigated and reported the epidemiological condition and distribution worldwide. People were seriously affected many times due to the direct consumption of unpasteurized milk.

Author	Participants	Total sample	Finding
[13]	Child	378	*Campylobacteriosis* cases of 2.12 and 1.14 and HUS cases of 0.02 and 0.09 were found in age 0- to 5-year, while 0.1 and 0.5 HUS in 5-year age group.
[38]	Women aged 55-69 years	22,808	Among 2,379 cancer patients, participants reported consuming unpasteurized milk only as children (RR = 0.90, 95 % CI: 0.82-0.99) or as children and adults (RR = 0.85, 95 % CI: 0.75-0.97) had a lower age-adjusted risk of cancer.
[10]	All age group	480	Among the respondents, 48 consumers self-report human *TB* case history
[9]	Children <15 years	721	*Brucellosis infections* cases had detected 103 (22.4%) with a history of consuming raw milk products.
[33]	Women aged 16-40, years	360	*Bad pregnancy outcomes were significantly different among study (p.0001).*
[39]	All age groups	4965	*(Hepatocarcinoma) HCC* occurrences related to the *AFM1* intakes were 0.005 and 0.004 cases per 100,000 people, respectively.
[26]	Children	15	*Brucella melitensis* were positive in 50% of the children.
[27]	All age groups	300	*Brucellosis* cases was associated with unpasteurized dairy product intake (OR = 3.7, p = 0.014) and OR = 7.55, p = 0.0001.
[31]	All age groups		There were 179 food-borne outbreaks were reported of which 2276 individuals were sick and one death.

Table 2: Disease-related consumption of unpasteurized milk on human health

HUS; Hemolytic uremic syndrome, OR; odd ratio; p; p-value; RR; Relative risk, IgM; AFM; Aflatoxin M1;

This investigation revealed that researchers examined 1,604 samples of raw milk and isolated *Staphylococcus aureus, campylobacteriosis, aflatoxin M1, E. coli 0157, Klebsiella, and pneumonia*, which could result in a potentially fatal condition for raw milk consumers in Table3.

Source of milk	Sample	Lab-diagnosed method	Hazards detected	Author
Cow milk	378	Culture and biochemical test	*Campylobacteriosis and hemolytic uremic syndrome* detected	[13]
Camel(25), Cow(23) & Goat(87)	135	ultra-sensitive LC-MS/MS	*Aflatoxin M1* was detected in sampled cow and goat milk, with 13% and 55%, respectively.	[16]
Cow milk	315	Culture and biochemical test	*Escherichia coli, Klebsiella pneumonia, Staphylococcus aureus, K. oxytoca, and Citrobacter Freunde*	[1]
Cow milk	300	Culture and biochemical test	From analyzed milk sample 36.66% and 56.66% harbored *E. coli and Staphylococcus aureus* respectively.	[11]
Cow milk	126	Culture and biochemical test	Unpasteurized milk consumer RR 6.27(2.10-18.76) with *Sorbitol-fermenting Escherichia coli O157.*	[19]
Cow milk	200	Culture and biochemical test	*Staphylococcus aureus (46%), coagulase-negative Staphylococcus aureus (29%), Escherichia coli (12%), Streptococcus agalactiae (8%) and Salmonella spp. (5%).*	[14]
Cow milk	150	Biochemical & serological	*E.coli and Aeromonas hydrophila* were examined in the milk sample with 32(21.3%) and 28(18.6%) respectively.	[14]

Table 3: Dangerous contents presented in raw milk

ng/L; nanogram per liter, Max; Maximum, RR; Relative Risk,

DISCUSSION

The finding of this systematic review found that significant results were provided with a review of fifteen papers. Raw milk consumed children were 2.21 times and 1.14 times more likely to acquire campylobacteriosis and hemolytic uremic syndrome than their counterparts [13]. Brucellosis occurred in 41.4 out of every 100,000 people. Among the participants, 170 patients (37 percent) had direct exposure to domestic animals, while 103 cases (22.4%) had a history of consuming raw milk products [9]. Similarly, 50% of investigated children consumed raw camel milk and confirmed brucellosis [26]. Another study found that among 300 patients, brucellosis was reported (OR = 7.55, p = 0.0001), of which unpasteurized dairy consumers were 3.7 times more likely than non-cased [27]. Moreover, the study found that unpasteurized milk consumers showed Toxoplasma Gondi in the specimen, which result in negative pregnancy outcomes [33]. The review study also found that 179 food-borne outbreaks were reported, and approved that unpasteurized milk was dominant to cause outbreaks, 2276 individuals were affected by numerous milk-borne

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[31]. Another study also found that among 480 study participants consumed raw milk, of which forty-eight manifested TB case history [10]. Another study investigated through prospective cohort design to find out that manifestation of cancer cases was observed among raw milk consumers [38]. Serraino et al. (2019), estimated that fractions of (Hepatocarcinoma)HCC incidences attributable to the AFM1 intakes were 0.005 and 0.004 cases per 100,000 individuals in the 0–0.9 and 1–2.9-year age groups, respectively, and below 0.004 cases in the other age categories [39]. Similarly, laboratory investigation results found that raw milk contains Aflatoxin M1, which is the most toxin in the body and results in hepatocarcinoma for human health [16]. Different studies found that E.coli, Klebsiella, pneumonia, Staphylococcus aureus, and coagulase-negative staphylococcus were commonly presented in unpasteurized milk results poor food handlers and animals' health status [1,11,14]. Similarly, sorbitol-fermenting E.coli 0157 and Aeromonas hydrophila are also found in unpasteurized milk and its products [19,29].

CONCLUSION

This review paper found that raw or unpasteurized milk contains pathogenic microorganisms and parasitic infections including; campylobacteriosis, salmonellosis, brucellosis, Staphylococcus aureus, streptococcus, E.coli 0157, Toxoplasmosis, and Aflatoxin M1, which might cause life-threatening condition even death for consumers. Particularly, toddlers, children, pregnant mothers, and other immune-surprised individuals were highly susceptible and seriously affect their health.

Conflicts of Interest

The authors declare no conflict of interest.

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