Head & Face Medicine

RESEARCH

Open Access

Impact of postoperative dairy consumption on oral wound healing: critical analysis from a prospective, randomized and controlled trial

Tobias Otto[1,3*†], Jan Alfred Dittmann[1†], Jacob Stake[1,2,3], Dirk Szulczewski-Stake[2], Lukas Schipper[4] and Kai Wermker[1]

Abstract

Introduction In the German-speaking community of surgeons addressing the oral cavity, there has long been a prevailing opinion that dairy products could be harmful to oral wound healing, but is this true? This study sheds light on this issue based on clinical data of wound healing impairment rates.

Methods A patient questionnaire, clinical examination prior to surgery of the oral cavity and a postoperative examination at suture removal were used to assess whether altered wound healing impairment rates occurred because of dairy product consumption. This was done in the setting of a prospective, randomized, controlled, single-blinded, bicenter study in outpatient and inpatient settings.

Results Among the 257 patients participating 228 were included in the study, 227 had complete data sets and were used for our statistical analysis. The cohort was randomly divided into 105 dairy product consumers (intervention group) and 123 without dairy products (control group). In total, 45 wound healing impairments out of 227 patients (19.82%) were noted, including 20 (19.05%) in the group of dairy product consumers (intervention group) and 25 (20.33%) in the control group. The logistic regression model was unable to show a statistically significant association between dairy product consumption and wound healing impairment. (p = 0.26), (OR = 0.65).

Summary The study found no statistically significant associations that dairy product consumption has either a negative or positive effect on wound healing. (p = 0.26), (OR = 0.65).

Introduction

In German-speaking countries, the avoidance of dairy products after oral surgery is often recommended to promote wound healing [1, 2].

In Germany, approximately 300,000 procedures involving intraoral wounds are performed in an inpatient setting every year [3]. In addition, approximately 12 million teeth are extracted[4], and various other outpatient procedures are performed, meaning that a considerable number of procedures involving intraoral wounds can be assumed. Eighty-five percent of the German population consumes dairy products several

†Tobias Otto und Jan-Alfred Dittmann contributed equally to this study.

*Correspondence:
Tobias Otto
tobias.ot@gmx.de
[1] Department of Oral and Cranio-Maxillofacial Surgery, Klinikum Osnabrueck GmbH, Am Finkenhuegel 1, 49076 Osnabrueck, Germany
[2] Grafschafter Implant Center, Stadtring 43, 48527 Nordhorn, Germany
[3] Institution Under Public Law, University Clinic Muenster, Albert-Schweitzer-Campus 1, 48149 Muenster, Germany
[4] Institute for Medical Informatics, Biometry and Epidemiology (IMIBE), University Clinic Essen, Hufelandstr. 55, 45122 Essen, Germany

times a week and 41% daily, making dairy products one of the most frequently consumed foods [5]. This does not differ much in the rest of Europe and North America. Dairy products are recommended by the German Nutrition Society and the WHO as an essential part of a healthy diet. [6–8]

In a survey on recommendations issued by dentists, oral surgeons and maxillofacial surgeons in 2020, 65% of all dentists, 48% of all oral surgeons and 31% of all maxillofacial surgeons recommended avoiding dairy products in the postoperative period [1].

This showed a tendency that the more complex the operations performed, the less attention was paid to avoiding dairy products. This, in turn, suggests that clinical experience shows that dairy products do not lead to problems with wound healing.

However, where does the fear of dairy products come from, which, in an international context, is primarily a phenomenon in German-speaking countries? Historically, the recommendation to avoid dairy products was made only after the Second World War. Internationally e.g. the US and GB, the recommendations tend towards rather than away from dairy products. Overall, this approach contrasts with guidelines both in German-speaking countries and internationally, none of which make recommendations to avoid dairy products [2].

In German-speaking countries, various reasons are discussed as to why dairy products are harmful. In discussions with colleagues, for example, it is often stated that dairy products could have an infectious effect, that antibiotics would work less effectively, that sutures could dissolve more quickly due to the acidity of the lactobacilli or that wound healing would be compromised by dairy products and the lactobacilli they contain [1, 2].

In the present study, prospective clinical data was used for the first time to examine whether wound healing is compromised by dairy products.

Materials and methods

Ethics vote

An ethics committee vote was obtained before the start of the study. The ethics committee of the Lower Saxony Medical Association approved the study on June 8, 2021. Registered Number: Bo/29/2021.

Study design

Bicenter, prospective, controlled, randomized and single-blinded at treatment side: Doctor performing surgery as well as doctor completing the postoperative questionnaire were blinded.

Population

Patients were included at two sites from 01.03.2023–01.04.2024. The Clinic for Oral and Maxillofacial Surgery in Osnabrück (Lower Saxony, Germany) has a predominantly inpatient study population with preexisting health conditions and an oral and maxillofacial surgery practice in Nordhorn (Lower Saxony, Germany), with a predominantly outpatient, healthier patient population. All patients who had undergone surgery involving an oral wound, regularly consumed dairy products and agreed to participate in the study were included.

Exclusion criteria were surgery without an oral wound surface, no regular consumption of dairy products, lactose intolerance or allergy, age under 16 years, ASA class 5 or 6, lack of ability to provide informed consent and pregnancy or breastfeeding (Table 1).

Study conduction

The study was advertised by approaching patients verbally and with flyers and information posters regarding the study. If patients agreed to participate in the study, they were randomized into two groups. Randomization was carried out by computer-assisted random numbers to assign the trial participants to one of the two intervention groups. The doctor who included the patients in the study always took the top study documents from a pile that was sorted according to the randomization list and thus included the patients according to the list. The doctor who created the list did not include any patients in the study. After receiving and opening the respective study documents and thus receiving the study group, the patients were explained how they had to behave with regard to dairy product consumption. The first group was asked not to consume any dairy products during the period between surgery and suture removal (control group), whereas the second group was explicitly told to consume dairy products as usual (intervention group). The sutures were removed on the 10 th–14 th postoperative day.

On admission directly before the operation, a standard clinical examination was performed with inspection of the face and oropharynx and completion of a preoperative questionnaire for the practitioner in which the wound situation was assessed preoperatively by an oral and maxillofacial surgeon (Table 2).

On admission, patients also completed a questionnaire in which factors commonly known as potentially influencing wound healing, such as preexisting health conditions and medication, as well as radiotherapy and chemotherapy, were assessed. [9–13]

Patients were also asked about their consumption of various dairy products and their frequency (Table 3).

Table 1 Characteristics of analysis population

Variable	Total (n = 228)	Treatment (n = 105)	Control (n = 123)
Post operative wound impairment yes N (%) [$n_{miss} = 0$]	45 (19.74%)	20 (19.05%)	25 (20.33%)
Age years Mean (SD) [$n_{miss} = 1$]	51.42 (18.93)	52.36 (17.83)	50.61 (19.87)
Sex male n (%) [$n_{miss} = 0$]	120 (52.63%)	57 (54.29%)	63 (51.22%)
Antiresorptives yes N (%) [$n_{miss} = 0$]	16 (7.02%)	10 (9.52%)	6 (4.88%)
Diabetes yes N (%) [$n_{miss} = 0$]	19 (8.33%)	2 (1.90%)	17 (13.82%)
Place clinic N (%) [$n_{miss} = 0$]	106 (46.49%)	51 (48.57%)	55 (44.72%)
Atherosklerosis yes N (%) [$n_{miss} = 0$]	15 (6.58%)	6 (5.71%)	9 (7.32%)
Chronic heartdisease yes N (%) [$n_{miss} = 0$]	2 (0.88%)	1 (0.95%)	1 (0.81%)
Bloodthinner yes N (%) [$n_{miss} = 0$] No Bloodthinner or preventive Heparine ASS or Clopidogrel Vitamin K antagonists, factor 10a antagonists, multi bloodthinner combinations	188 (82.46%) 18 (7.89%) 22 (9.65%)	87 (82.86%) 8 (7.62%) 10 (9.52%)	101 (82.11%) 10 (8.13%) 12 (9.76%)
Coagulation disorder yes N (%) [$n_{miss} = 0$]	6 (2.63%)	4 (3.81%)	2 (1.63%)
Adipositas yes N (%) [$n_{miss} = 4$]	135 (60.27%)	63 (61.76%)	72 (59.02%)
Smoking status smoker N (%) [$n_{miss} = 0$]	33 (14.47%)	14 (13.33%)	19 (15.45%)
Packyears ≥ 20 years N (%) [$n_{miss} = 0$]	47 (20.61)	21 (20.00)	26 (21.14%)
Immunosupression yes N (%) [$n_{miss} = 0$]	19 (8.33%)	8 (7.62%)	11 (8.94%)
Chemotherapie yes N (%) [$n_{miss} = 0$]	14 (6.14%)	7 (6.67%)	7 (5.69%)
Radiotherapie yes N (%) [$n_{miss} = 0$]	13 (5.70%)	9 (8.57%)	4 (3.25%)
Cardiovascular impairment yes N (%) [$n_{miss} = 0$]	167 (73.25%)	78 (74.29%)	89 (72.36%)
Immuno modulation yes N (%) [$n_{miss} = 0$]	33 (14.47%)	16 (15.24%)	17 (13.82%)
Immunodeficciency yes N (%) [$n_{miss} = 0$]	2 (0.88%)	1 (0.95%)	1 (0.81%)
Items excluded from logistic regression model:			
Number of tooth brushings per day Mean (SD) [$n_{miss} = 6$]	2.05 (0.57)	2.00 (0.50)	2.10 (0.62)
COPD yes N (%) [$n_{miss} = 0$]	7 (3.07%)	4 (3.81%)	3 (2.44%)
Chronic infectious diseases N (%) [$n_{miss} = 0$]	0 (0.00%)	0 (0.00%)	0 (0.00%)
Antibiotics yes N (%) [$n_{miss} = 35$]	99 (51.30%)	50 (56.82%)	49 (46.67%)
Kidneydisease yes N (%) [$n_{miss} = 0$]	1 (0.44%)	0 (0.00%)	1 (0.81%)
Liverdisease yes N (%) [$n_{miss} = 0$]	0 (0.00%)	0 (0.00%)	0 (0.00%)

Table 2 Preoperative Doctors questionnaire

Item No	Item			
1	Patient: Name, surname			
2	Patient birth date			
		Yes	No	Regio
3	Surgical site unremarkable without signs of			
4	Wound impairment			
5	Wound dehiscence			
6	Wound infection			
7	Abscess			
8	Necrosis (e.g. loss of flap)			
9	Os liber			
11	Inclusion criteria:			
12	regular consumption of dairy products			
13	Operation with intraoral wounding			
14	Exclusion criteria:			
15	Operation without intraoral wounding			
16	No regular dairy product consume			
17	Lactose allergy, lactose intolerance			
18	Age< 16			
19	ASA Class 5, 6 (moribund patient not expected to survive 24 hours with or without an operation, brain dead patient)			
20	Patient unable to consent			
21	Pregnancy/ breastfeeding			
22	If Exclusion criteria met => Exclusion from study.			
23	Inclusion into Study			

The procedure planned for the patient was then performed by a surgeon who was blinded to the study group. Depending on the study arm, the patients either consumed (intervention) or did not consume (control) dairy products postoperatively until suture removal between the 10 th and 14 th postoperative day. In the inpatient group, the nurses were instructed to ensure that the patients adhered to their administered diet and the nutrition plan during their inpatient stay was adjusted accordingly. In the outpatient group, the patients themselves ensured that they adhered to their administered diet.

At the time of suture removal, another oral and maxillofacial surgeon blinded to the treatment group recorded the status of wound healing and other factors that appeared relevant for wound healing via a blinded questionnaire and asked about compliance with the administered diet (Table 4).

The wound healing disorders were differentiated into various categories, and the localization was specified both in the preoperative assessment as well as the postoperative control in order to exclude the possibility that preexisting wounds elsewhere were classified as a wound healing disorder of the respective operation.

The wound healing disorder categories were as follows: Bland wound-mucosal conditions, non-irritant but delayed wound healing, wound dehiscence, wound infection, abscess, os liber, necrosis (possibly loss of flap).

Before starting the study, we calculated the sample size based on an estimated wound healing failure rate of 5%, which resulted in 652 patients to be included at a target significance level of $p = 0.05$ for a test on equality.

As the number of patients included was lower than estimated and the wound healing rate was significantly higher at 20%, we adjusted our equality test to a multivariate logistic regression model to account for confounding factors and compare the wound healing rates in both groups to determine the effect of the dairy products on wound healing.

Before starting the trial, the primary endpoint was defined as wound impairment rate depending on dairy product consumption. The secondary endpoints were determined by wound healing failure rates depending on the confounding diseases recorded in our questionnaire

Table 3 Patient questionnaire, queried factors possibly influencing wound healing. All items collected from the preoperative patient questionnaire. Options were yes or no. Items 38–46 could be answered with 1–2 per week, 2–4 per week, 5–7 per week and several times a day

Item No	Item
1	Name, surname:
2	Date of Birth:
3	Age:
4	Height in cm:
5	Weight in kg:
6	Gender M/F/X please tick
7	Do you currently smoke?
8	Yes: For ____ years, _____ packs/day
9	No: Quit smoking ____ years ago, previously ____ packs/day for ____ years
10	Never smoked
11	How often do you brush your teeth daily?
	Please answer which of the following diseases and medications you have, if possible hand us your medication plan:
12	Blood clotting disorder, if yes, which one?
13	Diabetes, if yes, please specify if Type 1 or Type 2:
14	Atherosclerosis (Do you have vascular calcifications?)
15	Chronic heart disease
16	Chronic obstructive pulmonary disease
17	Kidney disease
18	Liver disease
19	Immune deficiency
20	Chronic infectious disease (HEP B/C, tuberculosis, others) if others which ones?
21	Bisphosphonate or antibodies against bone metastases, bone cancer, or osteoporosis? (often administered once a week, month, year) If yes, for how long and which ones?
22	Immunosuppressive medications (e.g., cortisone, antibodies) (if yes, which ones, for how long?)
23	Oral contraceptives (if yes, which ones?)
24	Nifedipine (Adalat/Procardia)
25	Chemotherapy (if past, how long ago?)
26	Radiation therapy in the head-neck area (current or in the past)?
27	ASA (Aspirin/Godamed)
28	Clopidogrel (Plavix)
29	Ticagrelor (Brilique)
30	Marcoumar
31	Coumadin
32	Apixaban (Eliquis)
33	Edoxaban (Lixiana)
34	Rivaroxaban (Xarelto)
35	Dabigatran (Pradaxa)
36	Heparin
37	Others:
	Please answer which of the following dairy products you consume:
38	Milk (All types except milk substitute products)
39	Quark products
40	Cream products
41	Cream cheese products
42	Soft cheese products
43	Hard cheese products
44	Yogurt products, Kefir
45	Sour cream products (sour cream, crème fraiche)
46	Butter

Table 4 Postoperative doctor's questionnaire documenting wound healing status

Item No	Item			
1	Patient: Name, surname			
2	Patient: Birth date			
		Yes	No	Regio
3	Surgical site unremarkable			
4	Delayed wound healing lacking abnormalities			
5	Wound impairment if Yes which of the following?			
6	Wound dehiscence			
7	Wound infection			
8	Abscess			
9	Necrosis (e.g. loss of flap)			
10	Os liber			
11	Type of mouthwash please ask patient:			
12	Water			
13	CHX			
14	H2O2			
15	Perioperative antibiosis if yes specific drug:			
16	If current smoker: Smoking in the postoperative period?			
17	Did the patient follow the instructions regarding the dairy consume, please ask:			
18	Surgical procedure performed, please note in a few words:			

as well as patient characteristics regarding BMI, sex, age and confounding medications [14].

Statistical methods

Two hundred fifty-seven patients participated in the study. A total of 228 (88.7%) patients were included in the study and 227 patients (88,3%) were included in our analysis. 29 (11.3%) Patients were excluded from the study. Out of those 29, 7.8% of the patients respectively 20 were lost to follow up. Nine more were excluded from the study due to missing documentation or noncompliance regarding the study arm to which they were assigned (Fig. 1).

The patients were randomly divided into 105 (46.1%) dairy product consumers (intervention group) and 123 (53.9%) with postoperative cessation of dairy product consumption (control group).

Possible patient-specific factors influencing wound healing see Table 1 were considered in our study to adjust for confounding effects [15].

The statistical significance of dairy product consumption on wound impairment was determined in several stages. First data from the 3 questionnaires were analysed using descriptive statistics (Table 1) [16]. Then, a dimension reduction was carried out in order to reduce the number of potential regressors, which was too high for 45 events in the response variable [17]. This dimension reduction was carried out on the one hand based on a medical justification and on the other hand on the basis of a statistical justification. Data-driven variable selection was not used due to the negative effects on post-selection inference.

Initially, the dichotomous variable cardiovascular impairment was derived from the variables arteriosclerosis, chronic heart disease, blood thinner, coagulation disorder, obesity (BMI >30), active smoking status and number of pack years greater than or equal to 20. Cardiovascular impairment was defined as yes if at least one of these variables showed an event or if blood thinner was not taken purely as a preventive measure. Otherwise, it was defined as no.

In addition, the variables immunodeficiency, immunosuppression and chemotherapy were combined to form the variable immune modulation. This was defined as yes, if at least one of the combined variables showed an event, otherwise as no.

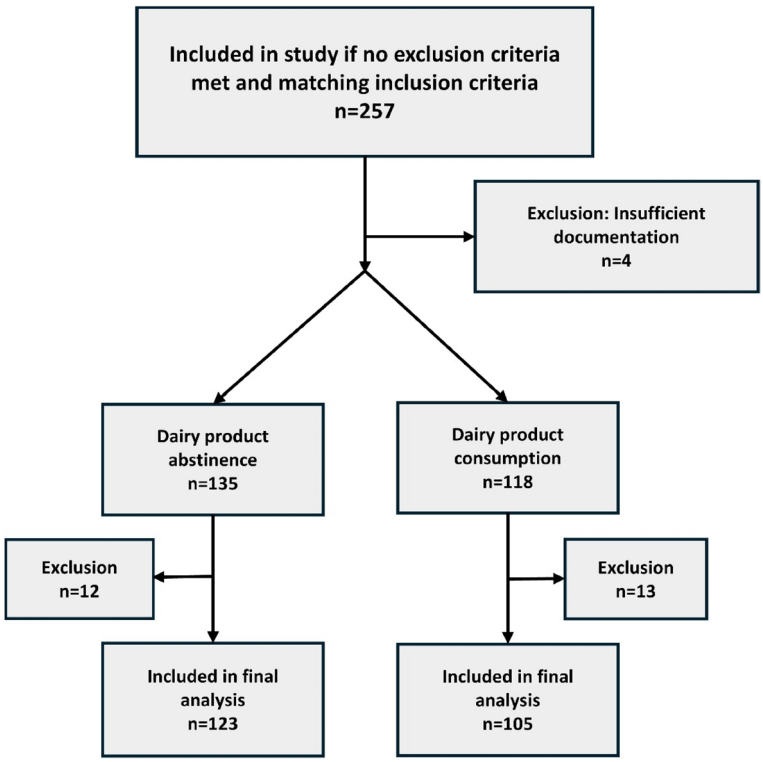

Fig. 1 Flowchart inclusion into study

The variables chronic infectious disease, kidney disease and liver disease were excluded from the analysis, as these variables had event frequencies between 0 and 0.44% in the entire patient population (see Table 1). COPD was also excluded from the analysis because the number of patients 7(3%) was small, the patients were divided very evenly between the two arms (3 to 4), because we did not expect COPD to have a major effect on wound healing and we wanted to include as few regressors as possible to keep the regression model as stable as possible. Due to potential reverse causation, as a high number of patients receive antibiotics in the first place due to wound healing disorders after surgery, antibiotics were excluded from the analysis to avoid reverse causation and the associated bias in the effect estimates.

The variable number of tooth brushings per day was also excluded from the model calculation, as only 1 patient stated that he brushed his teeth less than once a day. However, brushing teeth once or several times a day can be regarded as sufficient oral hygiene as performed sufficiently and thus as the same event from a medical point of view [18, 19]

This resulted in a total of 9 independent variables, namely cardiovascular impairment (yes/no), immunomodulation (yes/no), antiresorptive agents (yes/no), diabetes (yes/no), place of surgery (doctor's office/clinic), age (in years), gender (male/female), Radiotherapy (yes/no) and dairy products (yes/no). The latter variable was the regressor of interest, all other regressors served as covariates for adjustment.

Finally, the relationship between the dairy product and the dichotomous outcome variable post operative wound impairment (yes/no) was modelled using a logistic regression model and quantified using odds ratios. All analyses were performed using SAS version 9.4.

The within-sample classification ability of the model was indicated with the area under the curve (AUC) of a receiver operating characteristics (ROC) curve.

Results

45 Wound healing impairments out of 227 patients (19.82%) were noted, including 20 (19.05%) in the group of dairy product consumers (intervention group) and 25 (20.33%) in the control group. The logistic regression model yielded an odds ratio of 0.650 for the variable dairy product (yes vs. no). However, the confidence interval of this effect estimator ranged from 0.306 to 1.385, meaning that an association between dairy product and postoperative wound impairment could not be shown. ($p = 0.26$).

The results did, nevertheless, show a significant correlation between the location of the operation and the outcome variable. Patients who underwent surgery at

doctors office had a 0.262 times lower chance of developing a wound healing disorder than patients who underwent surgery in hospital CI [0.119; 0.577], p = 0.0009.

Radiotherapy significantly led to a very high chance of wound healing disorder with an odds ratio of 8.782, CI [1.854; 41.606], p = 0.0062.

With an odds ratio of 3.046, the administration of antiresorptives appears to be associated with the occurrence of wound healing disorders, although the confidence interval of the odds ratio included 1[0.823;11.275] and was not statistically significant (p = 0.0954).

All results are listed in Table 5. The area under the curve of the model was 0.7507.

Table 1 characterizing the patient cohort shows that randomization led to very homogeneous study arms regarding the investigated influencing variables.

However, diabetes was clearly asymmetrically distributed, with a total of 17 patients in the intervention group and two patients in the dairy product consumer group. We considered this to be most likely a random effect.

Our data indicate that the type of wound healing disorder was independent of the consumption of dairy products. Descriptive statistics showed that in the category of wound infections there was a clear difference between dairy product consumers and the intervention group. Wound infections occurred three times less frequently in the intervention group than in the group of dairy product abstinent patients (Table 6).

Discussion

The recommendation to avoid dairy products is problematic, as many patients are prescribed a soft diet after oral surgery and therefore find it difficult to avoid dairy products. Apart from this, dairy products are also recommended for a healthy diet by the WHO and the German Nutrition Society [7, 8]. A balanced and sufficient diet can be regarded as an assured factor for ideal wound healing. [20] Patients should therefore be made aware of the national nutritional recommendations. According to the German Nutrition Society and the World Health Organization, this also includes 2 portions of 250 g of milk or dairy products per day, fruit and vegetables, pulses, nuts, fish, vegetable oils and whole meal products. Meat consumption should be limited to 300 g/week, and sweet, salty and fatty foods should be avoided as much as possible.[6–8, 21]

In our study, no significant difference in wound healing was found between dairy product consuming intervention group and the dairy product-abstinent group. 20 Patients (19.05%) in the intervention group and 25 (20.33%) in the control group showed wound healing impairment (p = 0.26, OR 0.65, CI [0.306; 1.385]).

Much more relevant factors for wound healing in our study were the place of treatment: Doctors office vs. clinic OR 0.262; p = 0.0009.

Table 5 Results of the Regression model on factors influencing wound impairment rates

Regressor	Odds Ratio	95%- Confidence Interval	p-value
Dairy product yes vs. no	0.650	[0.306; 1.385]	0.2645
Cardiovascular impairment yes vs. no	1.308	[0.538; 3.179]	0.5540
Immuno modulation yes vs. no	0.449	[0.119; 1.694]	0.2371
Antiresorptives yes vs. no	3.046	[0.823; 11.275]	0.0954
Diabetes yes vs. no	0.781	[0.185; 3.290]	0.7359
Place doctors office vs. clinic	0.262	[0.119; 0.577]	0.0009
Age in years	0.981	[0.960; 1.002]	0.0759
Sex female vs. male	0.788	[0.365; 1.702]	0.5451
Radiotherapy yes vs. no	8.782	[1.854; 41.606]	0.0062

Table 6 Wound healing types dependant on dairy product consume

	Dairy product group			
	No dairy product intake		Dairy product intake	
	Count	Row n % related to total in group (123)	Count	Row n % related to total in group (105)
Post op delayed healing	6	4,9	6	5,7
Post op wound impairment	25	20,3	20	19,0
Post op wound dehiscence	20	16,3	19	18,1
Post op wound infection	9	7,3	3	2,9
Post op abscess	0	0,0	0	0,0
Post op necrosis	1	0,8	1	1,0
Post op os liber	3	2,4	4	3,8

Radiotherapy yes vs. no showed to have the strongest influence on wound impairment in our collective (OR 8.782; p = 0.0062). Numerous previous studies have confirmed this effect, which was also visible in this study. [11, 22].

Antiresorptive therapy which is a well known enfant terrible for all practitioners performing surgery of the jaws showed odds of 3.046 for wound healing impairment [23]. Due to a relatively low number of 16 patients (7.02%) in our collective we were not able to show this effect on a 5% significance level even though a CI of [0.823; 11.275] and p = 0.0954 was achieved.

Additional factors influencing wound healing were considered in our study to address possible confounding factors. These factors included chemotherapy, diabetes, immunosuppression, immunodeficiency, smoking, coagulation disorders, liver and kidney diseases, increased age, sex, low and high BMI as well as Atherosclerosis, COPD, chronic heart failure, chronic infectious diseases and treatment with nifedipine, which is known to have gingival side effects. [12] None of them could be identified in our study as a significantly influencing factor on wound healing rates, although they are known to have a negative effect on wound healing. The fact that we were unable to demonstrate a negative influence of these factors on wound healing is certainly partly due to the small number of patients with manifestations of these characteristics, but also to the fact that wounds in the mouth generally heal better than in most parts of the body. This is mainly due to the good vascularization, the good environment with moist and constant warmth as well as the high cell turnover of the oral mucosa. [24]

In our opinion, the lack of a negative effect of dairy product consumption on wound healing in our study can be explained well by refuting the following arguments In contrast, the consumption of dairy products could even be expected to have a positive effect on wound healing, although we were unable to demonstrate this effect in our study, which could presumably be due to the more long-term effect of a healthy diet on wound healing. However, the positive effect on dental health has already been proven in previous studies [25, 26].

A common argument against the consumption of dairy products is that milk reduces the effect of antibiotics. With the exception of doxycycline, antibiotics that interact with milk are rarely used in oral surgery. Most of the antibiotics used in this field, such as clindamycin, metronidazole, cefuroxime, and cefaclor, as well as penicillins such as amoxicillin and ampicillin sulbactam, do not interact with milk. [27, 28] Even if there is a potential interaction with milk, antibiotics can be taken two to three hours after ingesting dairy products without

the risk of interaction. The following antibiotics should be taken at least two hours after dairy products, as they interact with the calcium contained in milk in the form of complex formations: Doxycycline, tetracycline, minocycline and tigecycline, as well as fluoroquinolones such as ciprofloxacin, norfloxacin, moxifloxacin, ofloxacin, levofloxacin and enoxacin [27].

Another argument is that sutures disintegrate more quickly but an extensive in vitro experiment revealed that sutures do not dissolve faster as soon as they are colonized with lactic acid bacteria. Since sutures dissolve primarily in an alkaline environment, an opposite effect could even be expected here due to the acid formation of the lactic acid bacteria. [29, 30]

Opposing dairy product consumption due to concerns about pathogens has to be seen as historic. Products available for purchase nowadays are predominantly pasteurized or ultra highly heated and therefore free from harmful pathogens. This ensures that there are no pathogens in milk if raw milk is not consumed. However, the consumption of raw milk is recommended only by the responsible authorities after cooking and only for healthy adults. Apart from this, it is also not generally available for purchase and is subject to strict regulations. The quality and health safety of milk and dairy products in the EU are ensured by numerous European regulations. The regulations also ensure that there are no tuberculosis bacteria in milk, which is sometimes used as an objection to dairy products. [31–37]

Furthermore, it is being discussed that fibrinolytic plasmin in milk products can inhibit the formation of the coagulum. However, the plasmin concentration in milk is negligible compared to the plasma concentration, which is why it cannot be assumed that a significant fibrinolytic effect occurs. [38–40]

Finally, it is also often mentioned that dairy products form a film of mucus that serves as a bacterial lawn leading to reduced wound healing. Indeed, dairy products form a mucus film on the oral mucosa, which serves as a bacterial culture medium. Since this also happens with many other soft foods, however, it is not plausible why this should be more harmful with dairy products than with other foods. In fact numerous studies have investigated the benefits of lactic acid bacteria. [26, 41] The term probiotics usually refers to lactic acid-producing bacteria that are consumed as dairy products such as milk, yoghurt, kefir or fermented milk. Among all dairy product consumers, 5.5 million consumed probiotics at least once a week, and 13.5 million consumed probiotics at least once a month. [42] These bacteria usually include Lactobacillus and Bifidobacterium species. Probiotics are said to have various positive effects [43, 44]. Harmful influences on wound healing have been refuted [2]. They might have an anti-inflammatory effect on the gastrointestinal tract [45], might even have positive immunomodulatory effects [46], in addition, antibiotic-associated diarrhoea (AAD) can be reduced by probiotics. A meta-analysis of randomized placebo-controlled studies revealed a 38% reduction in AAD with early administration of probiotics during antibiotic therapy.[47] Beneficial effects have also been reported for mucositis therapy under radio- and/or chemotherapy, which occurs in almost all patients receiving radiotherapy in the head and neck area [41]. Therefore, it is difficult to understand why the consumption of these same lactic acid bacteria should lead to worsened wound healing. In contrast, it has already been shown that increased consumption of dairy products leads to reduced rates of periodontitis [26, 44, 48].

In our study, the loss-to-follow-up rate was approximately 7.8%. Most of these patients did not show up for suture removal due to the longer distance between our clinic and the family dentist. Those who did show up, however, justified their withdrawal from the study by stating that it was too difficult for them to give up dairy products and that it meant a too significant reduction in their quality of life during the postoperative period. This observation could already be made at the time of inclusion in the study. Most patients who could have been included in the study refused to participate by stating that they were not willing to take part in the randomization process, risking that they might have to give up dairy products for the period of 14 days. It is therefore questionable to what extent the frequently communicated dairy product restriction was and is complied with.

The present study suggests that wound healing is not compromised by the consumption of dairy products. If at all it tends towards a slightly positive effect of dairy product consumption with OR 0.65 jet far away from significance with $p = 0.26$ and a CI of [0.306; 1.385]. Therefore, the focus in the future should be on a balanced diet with dairy products, which is essential for the best possible wound healing [20, 21, 44, 48]. It has been indicated that dairy products containing probiotics have a positive effect on oral health. Wound healing also benefits from a favourable pH value and a reduced number of harmful bacteria [48]. It should therefore be discussed what an ideal environment for wound healing of the oral mucosa should look like including a discussion on what dietary strategies would be beneficial for patients undergoing surgery of the oral cavity.

Possible nutritional factors that can improve general and specifically oral wound healing have been identified in many studies. In particular, vitamin C, vitamin D, calcium and the intake of n-3 to n-6 unsaturated fatty acids

had positive effects on wound healing, especially in the mouth. [20]

In studies on wound healing not specifically related to the mouth, zinc, magnesium, vitamin E, high protein intake and probiotics were added to the substances already mentioned, all of which also had a positive effect on wound healing. However, the respective dosages cannot be clearly specified at present and should be the subject of further research. Apart from that differentiating between nutritional factors that specifically benefit oral wound healing only seems to make limited sense, as the mechanisms and substances required in the mouth do not differ significantly from the rest of the body. In conclusion, it can be stated that there is no one healing dietary supplement for optimal wound healing; instead, a balanced healthy diet that contains the above mentioned ingredients in sufficient quantities seems to be decisive. [20, 49, 50]

However, nutritional supplementation with the substances discussed earlier can be debated in the context of increased calorie requirement after an operation.

The additional energy consumption after elective surgery on the face is approximately 10%, but can increase up to 30% for major operations such as tumour resection.[51, 52] In the context of abdominal surgery, it has already been implemented that nutritional supplements should be started 7–14 days preoperatively as soon as there is a risk of malnutrition. In studies, the postoperative complication rate has been reduced by up to 25% in those protocols. [53–55] As many patients who undergo oral and maxillofacial surgery show signs of malnutrition before and at the latest after surgery, or at least have a high risk of malnutrition, preoperative nutritional screenings should also be increasingly used in oral and maxillofacial surgery. Particularly in the case of major operations, patients should be prepared for the operation preoperatively with nutritional supplements.

Frequent deficiency symptoms should be known so that they can be compensated for at least around the time of the operation. In the field of oral and maxillofacial surgery, these are often associated with alcohol and nicotine.

Smokers usually lack antioxidants due to increased occlusive stress and resulting increased consumption. In particular, vitamin C, β-carotene, selenium and zinc are also involved in weakened immune defence among many other nicotine-associated diseases [56–58].

Pathologic alcohol consumption leads to deficiency symptoms in many ways. The mucosa is negatively affected, intestinal motility is reduced, and the Na–K-ATPase of the basolateral mucosal membrane is inhibited, which impairs active transport processes in the intestinal tract. Patients with increased alcohol consumption are primarily deficient in vitamin B12, but vitamins B1, B2 and B6 are also lacking due to insufficient synthesis in the liver. Vitamins A, C and D are less absorbed, and folic acid levels are reduced. There is a lack of zinc, magnesium and selenium due to insufficient absorption [58, 59].

Data also show that elderly and poor patients have a significantly greater incidence of vitamin and micronutrient deficiencies than the average population [60].

In this respect, patients with a history of nicotine and alcohol consumption, as well as patients from poor and older social classes, should be considered at risk of malnutrition and malnourishment and should be given substitutes if necessary.

In conclusion, it can be stated that dairy products can and should serve as a source of nutrition both pre, peri- and postoperatively. Avoiding dairy products by switching to yeast-, pea- or soy-based milk substitutes can be useful for lactose-intolerant patients but has negative effects on the tooth structure and factors that promote wound healing [25, 44, 48]. In particular, many patients who have undergone surgery of the oral cavity are dependent on a soft diet, which often consists of dairy products. They should not be excluded based on questionable assumptions.

Limitations

Due to the number of 227 observations included in the analysis and the fact that the study was only conducted in a small part of Germany, it cannot be ruled out with certainty that local effects, or an insufficient number of cases could have falsified the study results. It is also conceivable that unknown confounders that we did not consider in relation to wound healing may have corrupted the results, which is why we can only speak of associations between the consumption of dairy products and wound healing disorders, although we were cautious to include all confounders that we found in the literature. However, these sources of error were counteracted by our consideration of previous illnesses and medication as well as the other factors asked about in the patient questionnaire. The study design and logistic regression model were key elements for eliminating those confounding effects. Using Table 1, we were further able to show that the randomization worked well, and the groups were homogeneous, which should counteract the effect of unknown confounders. The measurement of dairy product consumption in our outpatients could only be carried out using a questionnaire, which can lead to distorted or inaccurate data. To address this problem, we therefore asked about compliance with the assigned study arm in item 17 of the postoperative practitioner questionnaire. Nevertheless, we had to rely on the patients' answers, which was a problem that could not be resolved. Our

Study strongly implicates that there is no causal relationship between higher wound impairment rates and post operative dairy product consume but further studies in the future are necessary to test this hypothesis. Nevertheless, we believe that our study is a good indicator to this hypothesis due to the bicenter, prospective, single-blinded (practitioner), randomized and controlled study design, considering a diverse patient collective in terms of healthy outpatients and multimorbid inpatients, as well as the logistic regression modelling.

We do not believe that a higher number of patients would have changed the outcome towards showing a negative effect of dairy product consume on oral wound healing.

Summary

To our knowledge, this is the first study based on controlled, prospective, blinded and clinical data to show that there is no statistically significant association between worse wound healing and dairy product consumption after oral cavity surgery ($p = 0.26$, OR 0.65, CI [0.306; 1.385]). Among 228 patients 227 had complete data sets and were used for our statistical analysis. The cohort was randomly divided into 105 dairy product consumers (intervention group) and 123 without dairy products (control group). In total, 45 wound healing impairments out of 227 patients (19.82%) were noted, including 20 (19.05%) in the group of dairy product consumers (intervention group) and 25 (20.33%) in the control group.

Dairy product consumption did not lead to worse wound healing after surgery of the oral cavity. Even in the group with severe wound healing disorders, such as infection, necrosis, Os liber or abscess, no major differences were found in the distribution between the two groups. Negative effects attributed to dairy products (poorer effect of antibiotics, increased infection rates, faster dissolution of suture material and worse wound healing) have been refuted in various studies. In contrast, dairy products are recommended for a healthy and balanced diet, which is essential for good wound healing. In the form of probiotics, dairy products can have a positive influence on wound healing.

The main risk factor for nutrition-related wound healing disorders is therefore in our opinion based on thy study not the consumption of dairy products but under- or malnutrition. In the field of oral surgery, malnutrition is often associated with nicotine or alcohol and is accompanied by vitamin and mineral deficiencies such as B12, B1, B2, B6, A, C, D and folic acid; β-carotene; as well as selenium, magnesium and zinc.

The perfect nutritional supplement for wound healing has not yet been identified but should ideally contain a high protein intake, n-6 to n-3 unsaturated fatty acids, vitamin C, vitamin D, vitamin E, calcium, zinc, magnesium and probiotics, as all these substances have shown positive effects on wound healing in studies.

Overall, our study provides evidence challenging the recommendation against dairy consumption in surgery of the oral cavity within the German-speaking world. This dogma should therefore be critically questioned. If we want to address nutritional factors of wound healing, we should discuss smoking and alcohol cessation programs as well as nutritional supplementation prior to and post-surgery or promote recommendations for a healthy diet in general.

Acknowledgements
We would like to thank all the doctors at the Clinic for Oral and Maxillofacial Surgery Osnabrueck as well as the private practice practitioners in Nordhorn who completed the post-operative questionnaire. In addition, we are grateful for the support of all nurses and assistants of the oral and maxillofacial surgery ward and outpatient clinic of the Osnabrück Clinic for the care of the patients as well as the staff at the private practice in Nordhorn. Last but not least we want to thank LaetitiaS. Chiarella Bsc. for helpful advice about our manuscript.

Data protection
The study was conducted in accordance with German data protection laws. Consent for data processing and participation in the study was obtained in writing from each study participant.

Clinical trial number
Not applicable.

Authors'contributions
TO drafted the study design, carried out the formal procedures for registering the study, enrolled the patients at the Osnabrück Clinic, wrote the manuscript and carried out the data analysis. JD was significantly involved in improving the design of the study and editing the manuscript. JS enrolled the patients at the Szulczewski-Stake private practice and edited the manuscript. DS helped with the study conduction at his private practice and editing the manuscript. LS carried out the data analysis, performed the statistics and edited the manuscript. KW edited the manuscript and was involved in conducting the study as well as overlooking it.

Funding
The costs of the study were covered by the third-party funding account of the Clinic for Oral and Maxillofacial Surgery of the Osnabrück Hospital.

Data availability
Data is provided within the manuscript. The raw data can be requested by the corresponding author if there is a justified interest.

Declarations

Ethics Approval declaration
TA positive ethics vote was obtained from the Ethics Committee of the Medical Association of Lower Saxony, Germany (registered number Bo/29/2021).

Human Ethics and Consent to Participate declarations
The study was approved by the responsible ethics committee of the Medical Association of Lower Saxony in Hanover (registered number Bo/29/2021) and the hospital's own ethics committee at Osnabrück Hospital and was conducted in accordance with the 1964 Declaration of Helsinki.
All patients were informed verbally and in written form about the study and gave their written consent to both the processing of their data and their participation in the study.

Consent to publication
All authors consent to the publication of the above manuscript.

Competing interests
The authors declare no competing interests.

Received: 19 September 2024 Accepted: 23 April 2025
Published online: 17 May 2025

References

1. Seyedi Moghaddam S, Neff A. Milk and dairy products after dentoalveolar surgery—allowed or not? MKG-Chirurg. 2020;13:55–60. https://doi.org/10.1007/s12285-019-00238-1.
2. Seyedi Moghaddam S, Neff A. Avoidance of milk and dairy products after oral surgery-is such a recommendation still valid? A cross-sectional study among German and international oral and maxillofacial surgeons and dental practitioners with review of the literature. Oral Maxillofac Surg. 2022;26:563–73. https://doi.org/10.1007/s10006-021-01017-y.
3. Statistisches Bundesamt. Fallpauschalenbezogene Krankenhausstatistik (DRG-Statistik) Operationen und Prozeduren der vollstationären Patientinnen und Patienten in Krankenhäusern (4-Steller). 2021. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Krankenhaeuser/Publikationen/Downloads-Krankenhaeuser/operationen-prozeduren-5231401217014.pdf?__blob=publicationFile. Accessed 9 Apr 2024.
4. Bundes Zahnärztekammer Deutschland. Jahrbuch 2023 der Bundeszahnärztekammer mit Zahlen zu Zahnextraktionen. 2023. https://kzbv.de/static/flips/jahrbuch_2023_flip/. Accessed 9 Apr 2024.
5. Statista. Wie häufig konsumieren Sie durchschnittlich Milch oder Milchprodukte (z.B. Käse, Joghurt)? 2017. https://de.statista.com/statistik/daten/studie/717252/umfrage/haeufigkeit-des-konsums-von-milchprodukten-in-deutschland/. Accessed 10 Apr 2024.
6. Deutsche Gesellschaft für Ernährung e.V. Gesunde Ernährung. Ernährungskreis. 2024. https://www.dge.de/gesunde-ernaehrung/gut-essen-und-trinken/dge-ernaehrungskreis/. Accessed 12 Apr 2024.
7. Deutsche Gesellschaft für Ernährung e.V. Gut essen und trinken – die DGE-Empfehlungen. 2024. https://www.dge.de/gesunde-ernaehrung/gut-essen-und-trinken/dge-empfehlungen/. Accessed 12 Apr 2024.
8. World Health Organization. Healthy diet. 2020. https://www.who.int/news-room/fact-sheets/detail/healthy-diet. Accessed 12 Apr 2024.
9. Segura-Egea JJ, Cabanillas-Balsera D, Martín-González J, Cintra LTA. Impact of systemic health on treatment outcomes in endodontics. Int Endod J. 2023;56(Suppl 2):219–35. https://doi.org/10.1111/iej.13789.
10. Snäll J, Kormi E, Lindqvist C, Suominen AL, Mesimäki K, Törnwall J, Thorén H. Impairment of wound healing after operative treatment of mandibular fractures, and the influence of dexamethasone. Br J Oral Maxillofac Surg. 2013;51:808–12. https://doi.org/10.1016/j.bjoms.2013.08.015.
11. Jacobson LK, Johnson MB, Dedhia RD, Niknam-Bienia S, Wong AK. Impaired wound healing after radiation therapy: A systematic review of pathogenesis and treatment. JPRAS Open. 2017;13:92–105. https://doi.org/10.1016/j.jpra.2017.04.001.
12. Guo S, Dipietro LA. Factors affecting wound healing. J Dent Res. 2010;89:219–29. https://doi.org/10.1177/0022034509359125.
13. Grubbs H, Manna B. Wound Physiology. In: StatPearls: Wound healing phases. Treasure Island (FL); 2024.
14. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ. 2010;340: c869. https://doi.org/10.1136/bmj.c869.
15. Pourhoseingholi MA, Baghestani AR, Vahedi M. How to control confounding effects by statistical analysis. Gastroenterol Hepatol Bed Bench. 2012;5:79–83.
16. Hayes-Larson E, Kezios KL, Mooney SJ, Lovasi G. Who is in this study, anyway? Guidelines for a useful Table 1. J Clin Epidemiol. 2019;114:125–32. https://doi.org/10.1016/j.jclinepi.2019.06.011.
17. Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and Cox regression. Am J Epidemiol. 2007;165:710–8. https://doi.org/10.1093/aje/kwk052.
18. Kumar S, Tadakamadla J, Johnson NW. Effect of Toothbrushing Frequency on Incidence and Increment of Dental Caries: A Systematic Review and Meta-Analysis. J Dent Res. 2016;95:1230–6. https://doi.org/10.1177/0022034516655315.
19. Attin T, Hornecker E. Tooth brushing and oral health: how frequently and when should tooth brushing be performed? Oral Health Prev Dent. 2005;3:135–40.
20. Lau BY, Johnston BD, Fritz PC, Ward WE. Dietary Strategies to Optimize Wound Healing after Periodontal and Dental Implant Surgery: An Evidence-Based Review. Open Dental Journal. 2013;7:36–46.
21. Tunick MH, van Hekken DL. Dairy Products and Health: Recent Insights. J Agric Food Chem. 2015;63:9381–8. https://doi.org/10.1021/jf5042454.
22. Chronopoulos A, Zarra T, Ehrenfeld M, Otto S. Osteoradionecrosis of the jaws: definition, epidemiology, staging and clinical and radiological findings. A concise review Int Dent J. 2018;68:22–30. https://doi.org/10.1111/idj.12318.
23. Beth-Tasdogan NH, Mayer B, Hussein H, Zolk O, Peter J-U. Interventions for managing medication-related osteonecrosis of the jaw. Cochrane Database Syst Rev. 2022;7:CD012432. https://doi.org/10.1002/14651858.CD012432.pub3.
24. Sciubba JJ, Waterhouse JP, Meyer J. A fine structural comparison of the healing of incisional wounds of mucosa and skin. J Oral Pathol. 1978;7:214–27. https://doi.org/10.1111/j.1600-0714.1978.tb01596.x.
25. Shkembi B, Huppertz T. Impact of Dairy Products and Plant-Based Alternatives on Dental Health: Food Matrix Effects. Nutrients. 2023. https://doi.org/10.3390/nu15061469.
26. Al-Zahrani MS. Increased intake of dairy products is related to lower periodontitis prevalence. J Periodontol. 2006;77:289–94. https://doi.org/10.1902/jop.2006.050082.
27. Liste R. ROTE LISTE 2020 Buchausgabe Einzelausgabe: Arzneimittelverzeichnis für Deutschland (einschließlich EU-Zulassungen und bestimmter Medizinprodukte). 1st ed. Frankfurt am Main: Rote Liste Service GmbH; 2020.
28. Ahmadi H, Ebrahimi A, Ahmadi F. Antibiotic Therapy in Dentistry. Int J Dent. 2021;2021:6667624. https://doi.org/10.1155/2021/6667624.
29. Der BC. Einfluss von Laktobazillen auf Oberfläche und Eigenschaften von verschiedenen Nahtmaterialien [Dissertation]. Würzburg: Julius-Maximilians-Universität Würzburg; 2015.
30. Schwarz C. In Vitro- und In Vivi Untersuchungen zum Einfluss der Keimkontamination auf den Funktionsverlust resorbierbarer chirurgischer Nahtmaterialien [Dissertation]. Würzburg: Julius-Maximilians-Universität Würzburg; 2003.
31. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 178/2002 des Europäischen Parlaments und des Rates vom 28. Januar 2002 zur Festlegung der allgemeinen Grundsätze und Anforderungen des Lebensmittelrechts, zur Errichtung der Europäischen Behörde für Lebensmittelsicherheit und zur Festlegung von Verfahren zur Lebensmittelsicherheit; 28.01.2002.
32. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 852/2004 des Europäischen Parlaments und des Rates vom 29. April 2004 über Lebensmittelhygiene; 29.04.2004.
33. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 853/2004 des europäischen Parlaments und des Rates vom 29. April 2004 mit spezifischen Hygienevorschriften für Lebensmittel tierischen Ursprungs; 29.04.2004.
34. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 854/2004 des Europäischen Parlaments und des Rates vom 29. April 2004 mit besonderen Verfahrensvorschriften für die amtliche Überwachung von zum menschlichen Verzehr bestimmten Erzeugnissen tierischen Ursprungs; 29.04.2004.
35. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 2073/2005 der Kommission vom 15. November 2005 über mikrobiologische Kriterien für Lebensmittel; 15.11.2005.
36. Europäisches Parlament und Europäischer Rat. Verordnung (EG) Nr. 1662/2006 der Kommission vom 6. November 2006 zur Änderung der Verordnung (EG) Nr. 853/2004 des Europäischen Parlaments und des Rates mit spezifischen Hygienevorschriften für Lebensmittel tierischen Ursprungs; 06.11.2006.
37. Europäisches Parlament und Europäischer Rat. Durchführungsverordnung (EU) 2019/627 der Kommission vom 15. März 2019 zur Festlegung einheitlicher praktischer Modalitäten für die Durchführung der amtlichen

Kontrollen in Bezug auf für den menschlichen Verzehr bestimmte Erzeugnisse tierischen Ursprungs gemäß der Verordnung (EU) 2017/625 des Europäischen Parlaments und des Rates und zur Änderung der Verordnung (EG) Nr. 2074/2005 der Kommission in Bezug auf amtliche Kontrollen; 15.03.2019.
38. Belitz H, Grosch W, Schieberle P. Lehrbuch der Lebensmittelchemie. Berlin, Heidelberg: Springer Berlin Heidelberg; 2008.
39. Collen D, Tytgat G, Claeys H, Verstraete M, Wallén P. Metabolism of plasminogen in healthy subjects effect of tranexamic acid. J Clin Investig. 1972;51:1310–8.
40. Politis I, Lachance E, Block E, Turner JD. Plasmin and Plasminogen in Bovine Milk: A Relationship with Involution? Journal of dietary sciences. 1989;72:900–6.
41. Liu Y-C, Wu C-R, Huang T-W. Preventive Effect of Probiotics on Oral Mucositis Induced by Cancer Treatment: A Systematic Review and Meta-Analysis. Int J Mol Sci. 2022. https://doi.org/10.3390/ijms232113268.
42. Statista. Bevölkerung in Deutschland nach Häufigkeit des Konsums von probiotischen Milchprodukten von 2018 bis 2021 (in Millionen). 2021. https://de.statista.com/statistik/daten/studie/172353/umfrage/haeufigkeit-konsum-von-probiotischen-milchprodukten/. Accessed 10 Apr 2024.
43. Parvez S, Malik KA, Ah Kang S, Kim H-Y. Probiotics and their fermented food products are beneficial for health. J Appl Microbiol. 2006;100:1171–85. https://doi.org/10.1111/j.1365-2672.2006.02963.x.
44. Teughels W, van Essche M, Sliepen I, Quirynen M. Probiotics and oral healthcare. Periodontol. 2000;2008(48):111–47. https://doi.org/10.1111/j.1600-0757.2008.00254.x.
45. Bengmark S. Colonic food: pre- and probiotics. Am J Gastroenterol. 2000;95:S5-7. https://doi.org/10.1016/s0002-9270(99)00807-2.
46. Cristofori F, Dargenio VN, Dargenio C, Miniello VL, Barone M, Francavilla R. Anti-Inflammatory and Immunomodulatory Effects of Probiotics in Gut Inflammation: A Door to the Body. Front Immunol. 2021;12: 578386. https://doi.org/10.3389/fimmu.2021.578386.
47. Liao W, Chen C, Wen T, Zhao Q. Probiotics for the Prevention of Antibiotic-associated Diarrhea in Adults: A Meta-Analysis of Randomized Placebo-Controlled Trials. J Clin Gastroenterol. 2021;55:469–80. https://doi.org/10.1097/MCG.0000000000001464.
48. Nadelman P, Magno MB, Masterson D, Da Cruz AG, Maia LC. Are dairy products containing probiotics beneficial for oral health? A systematic review and meta-analysis. Clin Oral Investig. 2018;22:2763–85. https://doi.org/10.1007/s00784-018-2682-9.
49. Daher GS, Choi KY, Wells JW, Goyal N. A Systematic Review of Oral Nutritional Supplement and Wound Healing. Ann Otol Rhinol Laryngol. 2022;131:1358–68. https://doi.org/10.1177/00034894211069437.
50. Wild T, Rahbarnia A, Kellner M, Sobotka L, Eberlein T. Basics in nutrition and wound healing. Nutrition. 2010;26:862–6. https://doi.org/10.1016/j.nut.2010.05.008.
51. Müller-Richter U, Betz C, Hartmann S, Brands RC. Nutrition management for head and neck cancer patients improves clinical outcome and survival. Nutr Res. 2017;48:1–8. https://doi.org/10.1016/j.nutres.2017.08.007.
52. Giridhar VU. Role of nutrition in oral and maxillofacial surgery patients. Natl J Maxillofac Surg. 2016;7:3–9. https://doi.org/10.4103/0975-5950.196146.
53. Jie B, Jiang Z-M, Nolan MT, Efron DT, Zhu S-N, Yu K, Kondrup J. Impact of nutritional support on clinical outcome in patients at nutritional risk: a multicenter, prospective cohort study in Baltimore and Beijing teaching hospitals. Nutrition. 2010;26:1088–93. https://doi.org/10.1016/j.nut.2009.08.027.
54. Gustafsson UO, Scott MJ, Schwenk W, Demartines N, Roulin D, Francis N, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Clin Nutr. 2012;31:783–800. https://doi.org/10.1016/j.clnu.2012.08.013.
55. Miller KR, Wischmeyer PE, Taylor B, McClave SA. An evidence-based approach to perioperative nutrition support in the elective surgery patient. JPEN J Parenter Enteral Nutr. 2013;37:39S-50S. https://doi.org/10.1177/0148607113493928.
56. Preston AM. Cigarette smoking-nutritional implications. Prog Food Nutr Sci. 1991;15:183–217.
57. Northrop-Clewes CA, Thurnham DI. Monitoring micronutrients in cigarette smokers. Clin Chim Acta. 2007;377:14–38. https://doi.org/10.1016/j.cca.2006.08.028.
58. Galan P, Viteri FE, Bertrais S, Czernichow S, Faure H, Arnaud J, et al. Serum concentrations of β-carotene, vitamins C and E, zinc and selenium are influenced by sex, age, diet, smoking status, alcohol consumption and corpulence in a general French adult population. Eur J Clin Nutr. 2005;59:1181–90.
59. Adler G, Beglinger C, Manns MP, Müller-Lissner S, Schmiegel W. Klinische Gastroenterologie und Stoffwechsel. 1st ed. Berlin: Springer, Berlin; 2014.
60. Zarei M, Qorbani M, Djalalinia S, Sulaiman N, Subashini T, Appanah G, Naderali EK. Food Insecurity and Dietary Intake Among Elderly Population: A Systematic Review. Int J Prev Med. 2021;12:8. https://doi.org/10.4103/ijpvm.IJPVM_61_19.

Publisher's Note