Food Control 142 (2022) 109215

Contents lists available at ScienceDirect

Food Control

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

Safe week, unsafe weekend? Consumers' self-reported food safety practices and stomach sickness in cabin environments of varying infrastructure levels

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A R T I C L E I N F O

Keywords:
Food safety
Foodborne illness
Hygiene
Cottage
Infrastructure
Norway

A B S T R A C T

Food poisoning is a threat to health and economy across regions and living standards, with an estimated 600 million cases worldwide every year. In consumer households, water and electricity facilities are key to safe food preparation and storage. However, recreational home environments may be of lower standard and expose dwellers to higher risk of foodborne illness. The aim of this study was to assess risk behaviours in Norwegian cabin kitchens in relation to the level of cabin infrastructure and compared to home practices. Cabin dwellers (N = 339) answered an online questionnaire about infrastructure, appliances, cleaning routines, and food habits at the cabin and at home. Correspondence analysis was used to define three cabin types of low (16%), medium (31%) and high (53%) infrastructure. The cabin types were compared to one another as well as to home in terms of cabin visit frequency and length, kitchen equipment, cleaning practices, food consumption, and incidence of stomach sickness. Consumer practices were evaluated for their impact on potential exposure to foodborne pathogens in light of the food safety situation and recommendations in Norway. Large variations in cabin kitchen equipment were found, where 35% of the respondents did not have running water in the kitchen and 18% did not have a refrigerator. The lack of running water and/or electrical appliances in cabins appeared to lead to adaptive consumer practices regarding hygiene routines (e.g., more hand disinfectant). Food consumption differed from home towards safer choices in all cabin types (e.g., less raw chicken and more canned foods). The estimated incidence rate of stomach sickness was of 4‰ occurrences per day at the cabin. Across cabin types, the incidence rate was 4.0 times larger in low-infrastructure cabins and 3.1 times larger in medium-infrastructure cabins compared to high-infrastructure cabins. The results uncover a need for information campaigns on the elevated risk for foodborne illness in cabin environments and how consumers should change practices to reduce the risk.

1. Introduction

The importance of food safety cannot be underrated. Food poisoning is a threat to health and economy across regions and living standards, with an estimated 600 million (almost 1 in 10 people) cases and 420,000 deaths worldwide every year, corresponding to the loss of 33 million healthy life years (World Health Organization (WHO) (2020). In Europe, analyses from the World Health Organization (WHO) estimate that bacteria, parasites, toxins, and allergens in food account for about 23 million cases of illness and 5000 deaths every year (World Health Organization (WHO), 2015). In Norway, 5–7000 cases of food or water-related poisonings are reported every year (Lyngstad et al., 2021; Nygård & Kapperud, 2019) and the most commonly reported foodborne illness is campylobacteriosis (Norwegian Veterinary Institute, 2020). Case-control studies have shown that the water source (stream, river, lake, bottled water, or piped water supply serving less than 20 houses) and eating chicken, undercooked meat and barbeque are associated with a higher odds ratio of getting ill, while frequent washing of hands and utensils after contact with raw meat were associated with a lower odds ratio (MacDonald et al., 2015). *Toxoplasma gondii*, *Campylobacter* spp., enterohemorrhagic *E. coli* and *Listeria monocytogenes* were ranked as causing the highest disease burden among domestically acquired food-borne and waterborne pathogens in Norway in a recent report (Skjerdal et al., 2021). Norovirus, *Campylobacter* and *Bacillus cereus* scored highest in the number of incidences. *Salmonella* also scored high, but the majority of these cases are acquired abroad and the main risk factor for domestic cases is ingestion of sand and snow, typically during child's play (MacDonald et al., 2018). Common sources associated with food-related diseases in Norway were water, red meat and poultry, fresh produce, ready-to-eat foods (specifically smoked salmon, fermented

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https://doi.org/10.1016/j.foodcont.2022.109215
Received 30 March 2022; Received in revised form 28 June 2022; Accepted 30 June 2022
Available online 9 July 2022

fish, cold cuts, soft cheeses, and unpasteurized milk products), oysters, and unpasteurized milk (Skjerdal et al., 2021).

In the food value chain, food safety may be compromised in many instances from the food producer to the consumers' tables. To prevent the risk, food producers follow well-regulated food safety routines from production to packaging, storage and distribution. However, there is no such thing as well-regulated food safety routines in homes, and 40% of foodborne outbreaks in Europe are caused by food prepared in private homes (European Food Safety Authority (EFSA) and European Centre for Disease Prevention and Control (ECDC), 2019), highlighting the importance of the consumer stage (Røssvoll et al., 2013). In a study investigating European consumers' food safety practices in the home kitchen, Skuland and colleagues (Skuland et al., 2020) showed that when occurring, safe practices were seemingly performed without awareness, consistency or reasoning, and deviations to recommended food safety practices were frequent. The same consumer study showed however reasonable food safety levels in Norwegian homes: all the informants in Norway mentioned pathogens, and the authorities' food safety recommendations were more often observed in the Norwegian homes than in several other countries (Møretrø et al., 2021).

For Norwegian consumers, several external factors not related to direct food handling might contribute to good food safety in the home kitchen. Norway is one of the wealthiest countries in the world (The Organization for Economic Co-operation and Development (OECD), 2022) and virtually all households have electricity (The World Bank, 2022) as well as unlimited access to clean water (98%) (Macrotrends, 2022), wherein 90% of households benefit from running water of high quality from approved waterworks (Hyllestad, 2017). In parallel, almost all households have well-equipped kitchens including stoves, sinks, refrigerators and dishwashing machines (about 81%) (Møretrø et al., 2021). The Norwegians shop food more frequently than people in comparable countries (Norstat, 2016), therefore one might expect that the food they use at home is fresh and has not passed the use-by-date. Furthermore, a very popular home activity is refurnishing of the home (Elnan, 2021). One of IKEA's warehouses in Norway, for instance, was reported to have the second-largest sales of kitchen solutions worldwide (Helland, 2013). On these premises, food safety at home is generally high, benefitting from frequent shopping of fresh foods as well as new and updated kitchens and kitchen appliances.

Yet, another characteristic of the Norwegian lifestyle might complicate this picture. The country has about 450,000 recreational homes such as cottages and cabins (hereafter called "cabins") for a total of 2.5 million households (Statistics Norway, 2021a). Cabins are defined as leisure properties and are normally not registered as home-address of the owner but as a secondary residence (Helgerud, 2021). About one in five households have access to a cabin (Statistics Norway, 2022) and these are thought of as a second home, often more cherished than the main residence (Lien & Abram, 2018). Cabins are typically used in weekends and vacations, and one important reason for spending time in a cabin is the perception of simplicity and getting away from daily chores (Lien & Abram, 2018; Steffansen, 2017). The standard of Norwegian cabins varies from very simple to very luxurious. On the one hand, newly built cabins are modern, well-equipped, and located in areas serviced by electricity and water networks (Rye & Gunnerud Berg, 2011), but on the other hand, many cabins are older and more primitive, typically built at remote locations by a family member in a previous generation.

Norwegian cabin history began in the latter half of the 19th century, when the Norwegian Tourist Association opened up the countryside as a holiday destination (Jøsok Gansmo et al., 2011). In 1947, the Holiday Act came into force and gave Norwegian workers the right to three weeks' vacation. This triggered a tremendous demand for cabin plots and self-construction manuals (Olstad, 2009). Small and simple cabins raised in the mountains, the woods and by the shores. These cabins featured an outdoor toilet, a kerosene lamp, a wood stove, and water from the nearby stream as typical standard facilities. The cabin became a ubiquitous phenomenon sometime in the 1960s and has continued to grow parallel to the spread of individual cars, and to the development of new technology solutions increasing the comfort in cabins in terms of electricity from alternative sources, water, and sanitary installations.

Today, many cabins still offer a lower standard of equipment (i.e. power supply, running water, bathroom facilities, kitchen appliances) than Norwegian homes (Xue et al., 2020). Access to running water is a prerequisite to be able to comply with general hygiene advice regarding food safety in kitchens, for example for handwashing, rinsing vegetables and cleaning one's equipment (MacDonald et al., 2015; World Health Organization (WHO), 2006). It is known from low or middle-income countries that limited access to water (both distance to water source and amount of water) may increase gastrointestinal illness (Cassivi et al., 2019). Also, the lack of electricity may lead to a change in normal routines for heating and cooling of foods, which may have an impact on food safety. Such conditions may provoke foodborne illness with serious health consequences, in the worst case fatal consequences, especially for consumers at risk such as pregnant women, young children, people with diabetes or immuno-deficiency, and elderly people (Bintsis, 2017). Although Norwegian cabins and their uses are much studied, we have found no previous studies investigating the impact of low to high cabin infrastructure on food practices in a food safety perspective.

The aim of the study is to assess risk behaviors in cabin kitchens in relation to the level of cabin infrastructure and equipment, and compared to home practices. Based upon layman knowledge and previous literature, we hypothesise (i) a wide variation in facilities between cabins, ranging from home-like infrastructure and equipment standards to very basic, hut-like standards; (ii) a lower level of hygiene at the cabin than at home, and at low-infrastructure cabins than at high-infrastructure cabins; (iii) a lower consumption of foods associated with foodborne illness at the cabin than at home, and at low-infrastructure cabins than at high-infrastructure cabins, and (iv) a higher risk of foodborne illness at the cabin than at home, and at low-infrastructure cabins than at high-infrastructure cabins. The data material was collected through a web-survey. Cabins' infrastructure and consumer practices are evaluated in light of the World health's Organization's "Five keys to safer foods" (i.e, keep clean; separate raw and cooked; cook thoroughly; keep food at safe temperatures; and use safe water and raw materials) (WHO, 2006) and the food safety situation in Norway (Norwegian Veterinary Institute, 2020; Skjerdal et al., 2021). Consumer practices that can mitigate risk at the cabin are discussed. The results may be useful to food safety authorities in Norway and other countries with a culture of recreational homes.

2. Materials and methods

2.1. Data collection

A web-based survey on Norwegian consumers' food-related practices in cabins was conducted in December 2018–February 2019. The survey was an add-on to a larger online survey investigating kitchen equipment and food safety behaviour at home, performed in the EU-project SafeConsume (H2020 – SFS – 2016–2017: Project no. 727580). The full survey collected data from 1006 nationally representative households in Norway recruited through stratified random sampling based on the Nomenclature of Territorial Units for statistics level 2 (NUTS2) (Eurostat, 2020) and the education level of the target respondent. From this consumer sample, the subset of Norwegian respondents who disposed of a cabin (ownership or regular access) was invited to answer an add-on questionnaire on equipment, hygiene practices, and food practices at the cabin (see Appendix 1 for details). In total, 339 respondents completed the add-on cabin survey. The data were collected and handled with respect to the General Data Protection Regulation (GDPR) and in accordance with the ethical principles of the World Medical Association's Declaration of Helsinki. Recruitment was subcontracted to a professional survey provider (SSI, now Dynata).

2.2. Measures

The respondents were directed to the add-on cabin study upon answering "yes" to the question of whether they owned or disposed of a cabin. They were further asked to indicate the number and typical duration of their stays at the cabin in the past 12 months, the total number of days spent at the cabin in the past 12 months, and who they usually stayed with (Alone, Partner, Children, Other family, Friends, and/or Pets). The next section dealt with types of power and water facilities available at the cabin, access to running water in the kitchen, water-heating facilities, and sanitary facilities. In-depth questions measured handwashing and dishwashing possibilities, and equipment. Kitchen size, kitchen equipment type and equipment location (in the kitchen or nearby), and best-guess temperature in the fridge (if applicable) were collected to document similarities and differences with kitchen appliances found in homes as measured in the main survey. Furthermore, respondents made a self-assessment of their food safety practices at the cabin compared to home, including general and specific routines on hygiene and safe treatment of food. Additionally, the cabin dwellers' use of a selection of foods at the cabin compared to at home was measured. Finally, respondents reported whether they or one of their family members experienced stomach sickness/vomiting during, or as a result of, a stay at the cabin in the last 12 months (Yes/No). In addition, the number of general stomach sickness incidences in the last 12 months (stomach sickness with vomiting and/or diarrhoea, but not necessarily related to cabins) and demographic information were collected from the main survey.

The cabin questionnaire was developed by a transdisciplinary team of consumer researchers and food microbiologists, all familiar with the Norwegian cabin culture. General principles for constructing consumer surveys were applied (i.e., focus on the subject; clarity and specificity in wording; use of plain language; avoidance of leading questions; non-ambiguity of questions and response alternatives; exhaustivity and mutual exclusivity of choice alternatives; consistency in rating scales; brevity and parsimony) (Lawless & Heymann, 2010). Face validity of the questionnaire was established through experts in the topic (microbiologists) and psychometrics experts (consumer researchers). The questionnaire was pre-tested with colleagues at Nofima and Norwegian-speaking partners from the SafeConsume project, after which adjustments were made to the questionnaire. Pilot testing was conducted through a respondent recruitment in two steps. Preliminary models with principal component analysis were run to verify internal consistency and statistical stability of the data. See Appendix 1 for the full questionnaire on cabins.

2.3. Data analysis

For the descriptive tables, multiple choice questions were summarized as frequencies and percentages, and Likert scale questions were summarized as means and standard deviations. Cabin types were defined based on cabin facility questions (electricity, water source, running water and sanitary facilities; Q5-9 in the questionnaire, see Appendix 1) and lack of critical kitchen appliances (No fridge, No freezer and No dishwasher; Q18, Q19 and Q14). Using the binary table with facilities as columns and respondents/cabins as rows, a Correspondence Analysis (CA) was performed with the R package "FactoMineR" (Lê et al., 2008). Based on the first two dimensions of the scores plot, three cabin types with distinct infrastructure characteristics were defined visually and used for further comparisons.

The three cabin types were compared regarding cabin visit characteristics (Q1-4), kitchen equipment in or in proximity to the kitchen (Q18 and 19 combined), hand and dishwashing practices (Q10-16), differences in practices between the home and the cabin (Q22 hygiene practices/Q23 date label consideration/Q24 usage of cleaning items, and Q25 usage of food items) as well as the self-reported incidence of stomach sickness (Q26) during or in relation to a cabin stay within the last 12 months. For categorical responses, cabin types were compared via X^2 tests and in the case of small frequencies ≤ 5 with the Fisher's exact test. For numeric responses, cabin types were compared with an analysis of variance (ANOVA) and significance levels were determined with a Tukey test. Self-assessed food safety practices at the cabin compared to home, rated on a bipolar scale, were tested for H_0: $\mu = 0$, H_A: $\mu \neq 0$ with a one sample *t*-Test for the total cabin sample as well as for each cabin type. Further, kitchen equipment at the cabin was compared with the same respondent's kitchen equipment at home, representing paired data. For categorical responses, homes and cabins were compared via McNemar's test for paired binomial data. The numeric refrigerator temperatures at home and at the cabin were compared via a paired *t*-test.

The association of cabin type with self-reported stomach sickness was analysed with a logistic regression, with stomach sickness coded as binary dependent variable and cabin type as categorical independent variable (high-infrastructure serving as base level). Further, the incidence of stomach sickness per day at the cabin was computed per cabin type and for cabins in general, as the ratio of the total incidences to the total number of days spent at the cabin in the last 12 months. Correcting the reported incidences to the number of days at the cabin allows a risk interpretation focused on cabin types rather than on cabin usage frequencies. For comparison, the general incidence rate of stomach sickness (i.e., not necessarily related to cabins) in the last 12 months was estimated from the main survey. First, for each respondent the number of incidences reported were re-coded as a binary variable, analogous to the cabins data. Then, the incidence rate was computed based on a 365-day period. This was applied both to the cabin-dweller sample ($n = 339$) and the non-cabin dweller sample ($n = 667$) separately.

All analyses were performed in R, version 4.0.4 (The R Foundation). Statistical significance was determined based on an alpha level of 5%.

2.4. Evaluation of risky practices and food consumption

To support results interpretation in terms of food safety hazard, a qualitative categorisation of facilities, equipment, practices, and food products was conducted. In consensus, two microbiologists defined what specific (lack of) equipment and/or which consumer practices for handwashing and dishwashing may increase the risk potential for foodborne diseases. This categorisation was based on the World health's Organization's "Five keys to safer foods" (World Health Organization (WHO), 2006) and previous knowledge on the effect of different handwashing practices (Burton et al., 2011; Huang et al., 2012). Further, several criteria were used to select what food categories should be included in the add-on cabin survey questionnaire: 1) Foods associated with a typical traditional Norwegian cabin vacation (e.g., cured meat, canned food, grill sausages), 2) Foods associated with pathogens ranked as high on disease burden or frequency in Norway (i.e., meat (*Toxoplasma*, *Campylobacter*, Enterohemorrhagic *Escherichia coli* (EHEC)), ready-to-eat foods (*L. monocytogenes*), raw vegetables (*Toxoplasma*, *Campylobacter*, EHEC) and mussels (Norovirus)) (Skjerdal et al., 2021), and 3) Foods or dishes that may typically become unsafe as a result of consumer practices (dishes made from raw meat (hygiene, cooking) and ready-to-eat items (cold storage)) (Bintsis, 2017). An overview of the selected food items and their categorisation criteria is available in Supplementary Table S1. The qualitative categorisation was then utilised to interpret differences in risk of foodborne illness in the comparative analyses between the home and the cabin, as well as between cabin types.

3. Results

3.1. Cabin dweller respondents

The 339 respondents from the Norwegian survey who were cabin dwellers were 44.6 years old on average (SD 18.5) and 43% were females. They were similar to the representative survey sample (1006 households in Norway) in terms of education, occupation, household size and kitchen type at home (data not shown). They differed in having slightly higher income (comparison cabin sample to remaining sample with Welch two-sample *t*-test: $t(638) = 3.7, p < 0.001$), in line with what other authors have found (Xue et al., 2020). Similarly to the representative sample, about half of the households included a person that belonged to a risk group with regard to foodborne diseases (pregnant women and families with young children, people with diabetes or immuno-deficiency, and elderly people). Further details on the respondents are presented in Supplementary Table S2.

3.2. Cabin types and cabin dwellers

About half of the cabins did not feature the typical facilities of Norwegian homes. Although a large share of cabins benefited from municipal networks for electricity (70%), relatively few benefited from water networks (39%), leading to the use of alternative water sources such as cisterns or bringing water along to the cabin (Supplementary Table S3). Alternative power sources were used such as solar energy (17%) or generators (12%). However, 10% of cabins did not have any source of electricity and 18% did not have a refrigerator at the cabin. Only 55% were equipped with a regular water heater, 65% with running water in the kitchen, and 49% with a flush toilet.

Cabins were analysed according to their facilities with a correspondence analysis. Fig. 1 reveals three main cabin types: *High infrastructure cabins* (n = 188, 53%) generally equipped with water and electricity supplied by the municipality, warm running water, and a flush toilet, *Medium infrastructure cabins* (n = 106, 31%) with alternative power sources (solar, generator, gas), but often without running water, and *Low infrastructure cabins* (n = 53, 16%), which would typically lack running water, hot water, electricity and a refrigerator or freezer. A closer description of kitchen equipment per cabin type is given in section 3.2 'Kitchen equipment' below.

Respondent and household characteristics differed between cabin types regarding several aspects (Supplementary Table S2). The perceived household income was significantly higher in high-infrastructure cabins compared to low-infrastructure cabins ($p = 0.008$). Respondents from high-infrastructure cabins were significantly older than respondents from medium-infrastructure cabins ($Mean_{high} = 47.4$ years, $Mean_{medium} = 40.1$ years, $p = 0.005$). The proportions of risk groups in households were similar, except for a borderline statistical significance regarding children under six years old, who tended to be more frequent in medium (17%, $p = 0.050$) compared to low (10%) and high-infrastructure cabins (8%). The fraction of respondents with experience in the health or food sector was highest in the low-infrastructure cabins (38%, $p = 0.014$) and lowest in the high-infrastructure cabins (18%). Further, low-infrastructure cabins had significantly larger household sizes ($Mean_{low} = 3.1$ persons, $p = 0.011$) than medium and high-infrastructure cabins ($Mean_{medium/high} = 2.6$).

In the following, the three cabin infrastructure groups form the basis for further comparisons of consumer practices in cabin environments.

3.3. Kitchen equipment

Respondents' homes contained more kitchen equipment than their cabins in the domains of cooking food, cooling food, dishwashing, storing food and food preparation areas, with only stoves/cooker tops, pantries and single sinks being as frequent in cabins as in homes (Table 1). Eighty-two percent of cabins (vs. 93% of homes) had a refrigerator, 56% (vs. 84%) had a freezer and 37% (vs. 89%) had a dishwasher. Further, 4% of cabins had a floor hatch or cold basement but no refrigerator, 7% had no inside cooking facilities, 15% had no electrical cooling facilities, 16% had no food preparation area, 18% had no sink nor dishwasher, and 20% had no food storage facilities.

As per the segmentation in cabin types that was applied, high-infrastructure cabins were equipped close to home standards and the three cabin types differed significantly regarding basic kitchen facility equipment for cooking, cooling, and dishwashing (Table 1, Supplementary Fig. S1). All cooking facilities, except barbeque and bonfire pan, differed between cabin types, where no inside cooking facilities were more frequent in low-infrastructure cabins (23%, $p < 0.001$). Most high-infrastructure cabins had a refrigerator (94%) and a freezer (78%), while less than half of the low-infrastructure cabins had a refrigerator, and only 15% reported to have a freezer. Regarding dishwashing

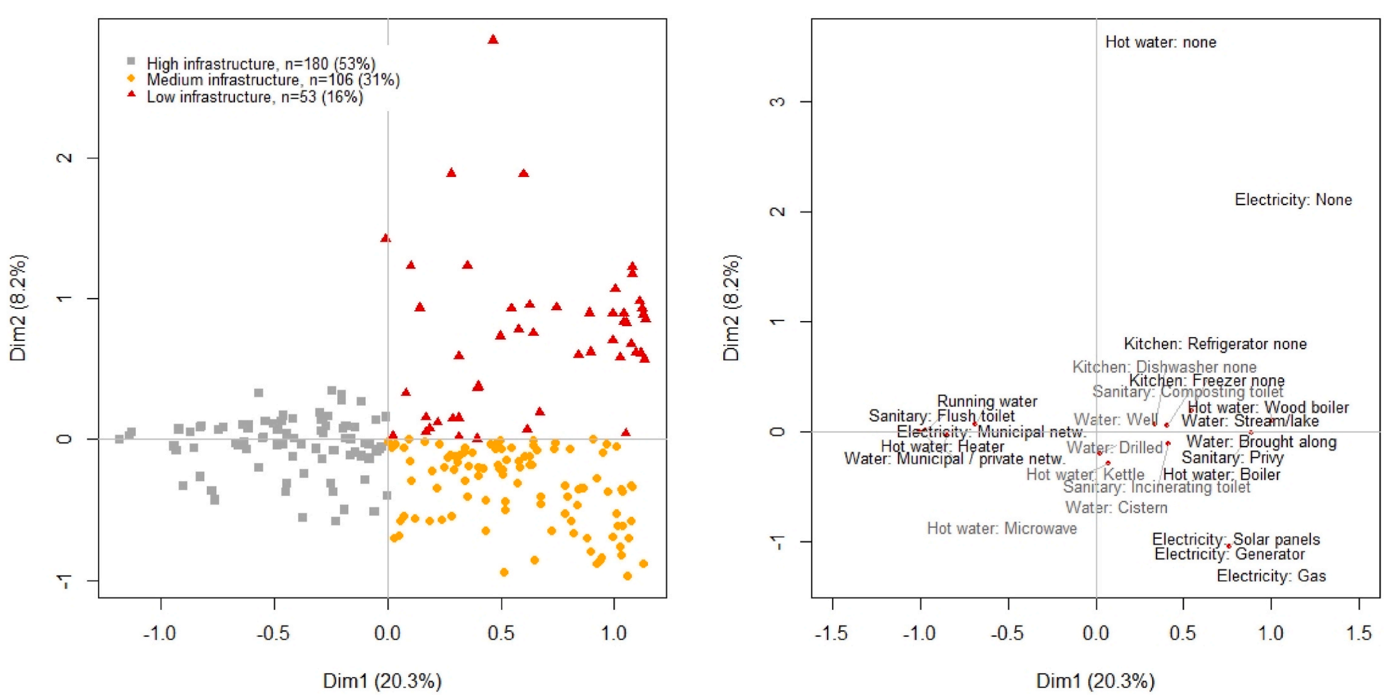

Fig. 1. Correspondence analysis of cabin facilities as binary variables (0/1). a) Based on the first two components, three cabin types were defined (high, medium and low infrastructure), b) Facility variables (black: contribution to first two dimensions >3%, grey: contribution ≤3%).

Table 1
Kitchen equipment at home and at the cabin, per cabin type. Italics indicate combination variables deducted from multiple question alternatives.

		Home (n = 339)	All cabins (n = 339)	Comparison between home and cabin[a]	High infrastr. (n = 180)	Medium infrastr. (n = 106)	Low infrastr. (n = 54)	Comparison of cabin types[b]
Category	**Items**	% (N)	% (N)	p-value	% (N)	% (N)	% (N)	p-value
Cooking	Stove	88 (299)	73 (247)	0.683	83 (149)	67 (71)	51 (27)	**<0.001**
	Cooker top		42 (142)		50 (90)	37 (39)	25 (12)	**0.002**
	Oven	92 (311)	64 (218)	**<0.001**	74 (134)	56 (59)	47 (25)	**<0.001**
	Microwave	79 (266)	45 (154)	**<0.001**	61 (110)	30 (32)	23 (12)	**<0.001**
	No inside cooking facilities	*3 (10)*	*7 (25)*	***0.018***	*1 (2)*	*10 (11)*	*23 (12)*	***<0.001***
	Barbecue	n/a	28 (96)	n/a	24 (44)	37 (39)	25 (13)	0.063
	Bonfire pan	n/a	17 (59)	n/a	17 (30)	20 (21)	15 (8)	0.606
Cooling	Refrigerator	93 (315)	82 (279)	**<0.001**	94 (170)	80 (85)	45 (24)	**<0.001**
	Freezer	84 (284)	56 (189)	**<0.001**	78 (140)	39 (41)	15 (8)	**<0.001**
	No electrical cooling facilities	*4 (14)*	*15 (51)*	***<0.001***	*4 (7)*	*17 (18)*	*49 (26)*	***<0.001***
	Floor hatch/Cold basement	n/a	15 (52)	n/a	8 (15)	20 (21)	30 (16)	**<0.001**
	Floor hatch/Cold basement and no refrigerator	*n/a*	*4 (15)*	*n/a*	*0 (0)*	*3 (3)*	*23 (12)*	***<0.001***
	Cooler bag	n/a	16 (55)	n/a	8 (15)	23 (24)	30 (16)	**<0.001**
	Cooler bag and no refrigerator	*n/a*	*5 (16)*	*n/a*	*0 (0)*	*6 (6)*	*19 (10)*	***<0.001***
Dish washing	Single sink	39 (133)	45 (154)	0.099	43 (78)	50 (53)	43 (23)	0.522
	Double sink	64 (217)	35 (119)	**<0.001**	49 (88)	23 (24)	13 (7)	**<0.001**
	Dishwasher	89 (303)	37 (126)	**<0.001**	57 (103)	15 (16)	13 (7)	**<0.001**
	No sink or dishwasher	*5 (17)*	*18 (62)*	***<0.001***	*7 (13)*	*28 (30)*	*36 (19)*	***<0.001***
Storage	Cupboards for keeping ingredients	89 (303)	76 (256)	**<0.001**	81 (145)	74 (78)	62 (33)	**0.021**
	Pantry	21 (70)	19 (63)	0.550	17 (30)	20 (21)	23 (12)	0.571
	No food storage facilities	*9 (31)*	*20 (67)*	***<0.001***	*17 (30)*	*23 (24)*	*25 (13)*	*0.271*
Preparation	Small countertop where one person can comfortably prepare a meal	46 (156)	53 (178)	0.095	49 (89)	58 (62)	51 (27)	0.325
	Larger countertop where two or more persons can comfortably prepare a meal	68 (231)	30 (103)	**<0.001**	40 (72)	23 (24)	13 (7)	**<0.001**
	Kitchen table	80 (270)	62 (209)	**<0.001**	67 (120)	60 (64)	47 (25)	**0.035**
	No food preparation area	*5 (16)*	*16 (55)*	***<0.001***	*13 (23)*	*18 (19)*	*25 (13)*	*0.090*

[a] McNemar-Test for paired binomial data.
[b] X^2 test for $n > 5$ and Fisher's exact test for $n \leq 5$.

facilities, no significant difference was detected for access to a single sink, however the high-infrastructure cabins had a higher proportion of dishwashers (57%, $p < 0.001$). No access at all to either a sink or a dishwasher, was more frequently observed for medium- and low-infrastructure cabins than for high-infrastructure cabins. The low-infrastructure cabins also had a smaller food preparation area in the kitchen than the other cabin types: only 13% had a larger countertop where two or more persons could comfortably prepare a meal, and one in four respondents reported no specific food preparation area in the kitchen at all (Table 1).

Finally, in the subsample that indicated the refrigerator temperature for both home and cabin (n = 212), no significant refrigerator temperature difference was found between homes and cabins (Mean $_{home}$ = 4.2 °C, SD = 1.7; Mean $_{cabin}$ = 4.4 °C, SD = 1.9; $t(212) = 0$, $p = 1$).

3.4. Cabin hygiene practices

In line with available equipment, hygiene practices also differed between cabin types (Table 2). In high-infrastructure cabins, 9 out of 10 washed hands in running water, while only one out of four reported this possibility in medium- and low-infrastructure cabins ($p < 0.001$). Differences in practices were also evident for water temperature where 40% and 43% of medium and low-infrastructure cabin dwellers, respectively, reported using cold water for handwashing compared to only 8% in the high-infrastructure cabins ($p < 0.001$). Use of towels versus wiping paper also differed between cabin types, where towel use was most frequent in high-infrastructure cabins ($p = 0.001$).

Based upon the options offered to the consumers in the questionnaire, the safest practice for washing hands was defined as combining the following answer items: "Washing in running water AND warm water AND always with soap AND drying with wiping paper or towel". The most unsafe practice was defined as "Washing in a basin where the water is not changed each time (i.e., changed several times each day OR changed daily or less frequently) AND never using soap". The safety evaluation of handwashing practices (see Table 2) showed significantly safer practices in high-infrastructure cabins (79%), and less unsafe practices (3%) compared to the other cabin types ($p < 0.001$).

Lack of infrastructure also influenced dishwashing practices between the cabin types (Table 2). Using a dishwasher or running water were reported by 9 out of 10 in the high-infrastructure group, while 60 and 51 percent of medium and low-infrastructure cabin dwellers, respectively, reported washing dishes in the sink without running water ($p < 0.001$). The rinsing steps before and after washing also differed between medium and low-infrastructure cabin dwellers and high-infrastructure cabin dwellers, the former two reporting using cold water more often ($p < 0.01$).

Based upon the options offered to the consumers in the questionnaire, the safest practice for dishwashing was defined as: "Cabins that either had a dishwasher OR followed the following dishwashing procedure; Washing step: warm water AND Rinsing step: cold OR hot water AND Tools: detergent AND dish brush OR sponge". The most unsafe practice was defined as answering "No detergent AND No dishwashing". The safety evaluation of dishwashing practices (see Table 2) showed significantly safer practices in high-infrastructure cabins (92%), and unsafe practices in low-infrastructure cabins (24%) ($p < 0.001$).

3.5. Self-evaluated hygiene and food consumption practices compared to home

Consumer practices were self-assessed as significantly better at home than at the cabin in the domains of handwashing, kitchen cleaning, dishwashing, storage of food and cooking, for cabins in general as well

Table 2
Hygiene practices at the cabin. *Italics* indicate combination variables deducted from multiple question alternatives.

			All cabins (n = 339)	High infrastr. cabins (n = 180)	Medium infrastr. cabins (n = 106)	Low infrastr. cabins (n = 54)	Comparison of cabin types[a]
Category	**Question**	**Items**	% (N)	% (N)	% (N)	% (N)	*p*-value
Handwashing	Method	In running water	59 (200)	89 (161)	24 (25)	26 (14)	**<0.001**
		In a bowl where water is changed for each time	12 (42)	3 (6)	22 (23)	25 (13)	
		In a bowl where water is changed several times each day	15 (52)	3 (5)	27 (29)	34 (18)	
		In a bowl where water is changed daily or less frequently	4 (14)	1 (1)	9 (10)	6 (3)	
		With wet wipes	8 (27)	2 (4)	17 (18)	9 (5)	
		Other	1 (4)	2 (3)	1 (1)	0 (0)	
	Water temperature	In cold water	23 (79)	8 (14)	40 (42)	43 (23)	**<0.001**
		In warm water	68 (229)	88 (159)	42 (45)	47 (25)	
		n/a[b]	9 (31)	4 (7)	18 (19)	9 (5)	
	Soap usage	Soap, every time	73 (246)	82 (148)	60 (64)	64 (34)	0.075
		Soap, sometimes	17 (58)	13 (24)	20 (21)	25 (13)	
		No soap	1 (4)	1 (1)	2 (2)	2 (1)	
		n/a[b]	9 (31)	4 (7)	18 (19)	9 (5)	
	Hand drying	Towel/kitchen towel	69 (233)	81 (145)	53 (56)	60 (32)	**0.001**
		Wiping paper	18 (60)	13 (24)	23 (24)	23 (12)	
		Your clothes	3 (10)	1 (1)	6 (6)	6 (3)	
		Air drying	1 (5)	2 (3)	1 (1)	2 (1)	
		n/a[b]	9 (31)	4 (7)	18 (19)	9 (5)	
	Safety evaluation	*Safest practice*[c]	*60 (184)*	*79 (137)*	*37 (32)*	*31 (15)*	***<0.001***
		Most unsafe practice[d]	*16 (53)*	*3 (5)*	*28 (30)*	*34 (18)*	***<0.001***
Dishwashing	Method	I never take the dishes myself	8 (28)	7 (13)	7 (7)	15 (8)	**<0.001**
		In the dishwasher	37 (126)	57 (103)	15 (16)	13 (7)	
		Wash with running water	26 (88)	33 (60)	17 (18)	19 (10)	
		In the sink without running water	28 (95)	2 (4)	60 (64)	51 (27)	
		Other	1 (2)	0 (0)	1 (1)	2 (1)	
	Rinsing dirt step	Without water	11 (37)	3 (6)	19 (20)	21 (11)	**0.005**
		In cold water	13 (43)	6 (10)	21 (21)	21 (11)	
		In hot water	31 (105)	27 (48)	39 (41)	30 (16)	
		n/a[e]	45 (154)	64 (116)	22 (23)	28 (15)	
	Washing step	In cold water	5 (16)	2 (3)	8 (8)	9 (5)	0.283
		In hot water	50 (169)	34 (61)	71 (75)	62 (33)	
		n/a[e]	45 (154)	64 (116)	22 (23)	28 (15)	
	Rinsing the soap step	In cold water	13 (44)	4 (8)	22 (23)	25 (13)	**0.008**
		In hot water	36 (123)	29 (53)	45 (48)	42 (22)	
		Do not rinse	5 (18)	2 (3)	11 (12)	6 (3)	
		n/a[e]	45 (154)	64 (116)	22 (23)	28 (15)	
	Drying	Towel	40 (134)	26 (47)	58 (62)	47 (25)	0.580
		Air dry	15 (51)	9 (17)	20 (21)	25 (13)	
		n/a[e]	45 (154)	64 (116)	22 (23)	28 (15)	
	Tools	Dish brush	48 (163)	32 (57)	69 (73)	62 (33)	0.957
		Sponge	13 (44)	5 (9)	22 (23)	23 (12)	0.070
		Detergent	46 (156)	30 (54)	71 (75)	51 (27)	**0.025**
		Dishwashing gloves	17 (59)	11 (20)	26 (28)	21 (11)	0.864
		Basin/sink	30 (103)	16 (28)	53 (56)	36 (19)	**0.012**
	Safety evaluation	*Safest practice*[f]	*81 (253)*	*92 (154)*	*71 (70)*	*64 (29)*	***<0.001***
		Most unsafe practice[g]	*9 (29)*	*6 (10)*	*8 (8)*	*24 (11)*	***<0.001***

[a] X^2 test for $n > 5$ and Fisher's exact test for $n \leq 5$.
[b] not answered by respondents who used "wet wipes" or "other" in hand washing method.
[c] Washing in running water AND warm water AND always with soap AND drying with wiping paper or towel.
[d] Washing in a basin where the water is not changed each time (several times each day OR changed daily or less frequently) AND never using soap.
[e] Not answered by respondents who either answered "I never do the dishes myself" or "In the dishwasher" in dishwashing method.
[f] Cabins that either had a dishwasher or followed the following dishwashing procedure: Washing step: warm water AND rinsing step: cold OR hot water AND tools: detergent AND dish brush OR sponge.
[g] No detergent AND No dishwashing.

as for each cabin type ($p < 0.001$, Table 3). Nonetheless, a Tukey test shows that high-infrastructure cabin dwellers reported more similar routines to home at the cabin than medium- and low-infrastructure cabin dwellers, except for food storage at medium-infrastructure cabins (Table 3). For a visualisation of these results, we refer to the Boxplot presented in Supplementary Fig. S2. Further, the respondents used less hand soap but more wet wipes at the cabin. Wet wipes and hand disinfectants were especially prevalent in medium-infrastructure cabins. Further, respondents reported to consume less foods after the "Use-by" date at the cabin than at home, especially in lower-infrastructure cabins. No significant differences occurred for the consumption of foods after the "Best before" date. The consumption of specific food products differed more often between home and the cabin than between cabin types. When the consumption varied, it was always in the direction of safer choices at the cabin, including a lower consumption of chicken-based dishes, smoked fish, soft cheeses, sushi and mussels, and a higher consumption of grill sausages and canned foods ($p < 0.001$). The only exception was a lower consumption of cooked vegetables ($p < 0.001$), which are considered a safe food, this especially in low- and medium-infrastructure cabins. It should be noticed that this was accompanied with a lower consumption of raw vegetables as well ($p < 0.001$), which may be unsafe if not washed appropriately (Table 3).

Table 3
Hygiene and food choice practices at the cabin compared to home. Practices evoking a significant increased risk of foodborne illness at the cabin are marked in red, while a significant decreased risk is marked in green.

		All cabins (n = 339)	High infrastr. (n = 180)	Medium infrastr.(n = 106)	Low infrastr. (n = 54)	Comparison of cabin types (ANOVA)
		Mean	Mean	Mean	Mean	p-value
If you compare a day at home with a day in the cabin, would you say that your routines for the following practices are … ?[1]	Handwashing	−0.5***	−0.2***^{b}	−0.8***^{a}	−0.9***^{a}	**<0.001**
	Kitchen cleaning	−0.5***	−0.3***^{b}	−0.7***^{a}	−0.8***^{a}	**<0.001**
	Dishwashing	−0.6***	−0.4***^{b}	−0.8***^{a}	−1.0***^{a}	**<0.001**
	Storage of food	−0.4***	−0.3***^{b}	−0.5***^{ab}	−0.8***^{a}	**<0.001**
	Cooking/heat treatment of food	−0.3***	−0.1***^{b}	−0.5***^{a}	−0.6***^{a}	**<0.001**
If you compare a day at home with a day in the cabin, how often do you use the following:[2]	Kitchen paper	0.1	0.0^{a}	0.2*^{b}	0.2^{ab}	**0.035**
	Cleaning wipes	0.3***	0.0^{a}	0.5***^{b}	0.6***^{b}	**<0.001**
	Sponge	−0.1	−0.1*	0.0	−0.2	0.422
	Dish brush	0.2***	0.0^{a}	0.5***^{b}	0.0^{a}	**<0.001**
	Plastic gloves for cooking	−0.2**	−0.3***	0.0	−0.3	0.051
	Dish soap	0.0	−0.1	0.1	−0.2	0.140
	Hand soap	−0.2***	−0.1*	−0.2*	−0.3*	0.213
	Wet wipes	0.2**	0.0^{a}	0.5***^{b}	0.2^{ab}	**<0.001**
	Hand disinfectant	0.1	−0.1^{a}	0.2*^{b}	0.2^{ab}	**0.013**
If you compare at home with the cabin, do you eat foods after expiration date … ?[2]	Consumption of foods after "Best before" date	0.0	0.0	0.0	−0.1	0.862
	Consumption of foods after "Use by" date	−0.1**	−0.1^{b}	−0.1^{ab}	−0.4**^{a}	**0.026**
For an equivalent number of meals, which of these items do you eat more often at home/at the cabin?[2]	Grill sausages	0.6***	0.6***^{ab}	0.8***^{b}	0.3*^{a}	**0.018**
	Raw chicken	−0.4***	−0.2***^{a}	−0.6***^{b}	−0.6***^{ab}	**0.010**
	Ready-made chicken	−0.3***	−0.2***	−0.3**	−0.4*	0.685
	Chicken salad	−0.3***	−0.2***	−0.3**	−0.4**	0.675
	Cold smoked fish	−0.2***	−0.1*	−0.2*	−0.4*	0.170
	Cream cheese	−0.1	−0.1	−0.1*	0.0	0.987
	Camembert	−0.3***	−0.2*^{a}	−0.4***^{a}	−0.5**^{a}	**0.023**
	Blue cheese	−0.3***	−0.3***	−0.3**	−0.4*	0.950
	Casserole	0.1	0.0	0.2*	0.0	0.308
	Raw vegetables	−0.2***	−0.1	−0.3**	−0.4**	0.111
	Cooked vegetables	−0.3***	−0.2**^{b}	−0.4***^{a}	−0.6***^{a}	**0.003**
	Potato chips	0.3***	0.3***	0.3**	0.2	0.906
	Hot chocolate	0.2***	0.2*	0.4***	0.1	0.207
	Sushi	−0.8***	−0.7***	−0.9***	−0.8***	0.387
	Mussels	−0.3***	−0.2*	−0.3*	−0.4	0.791
	Canned food	0.4***	0.4***	0.4***	0.2	0.474

[1]Five-point scale; −2: Much better at home; 0: Equivalent at home and at the cabin; 2: Much better at the cabin.
[2]Five-point scale; −2: Much more often at home; 0: Equivalently often at home and at the cabin; 2: Much more often at the cabin.
*** p-value < 0.001, ** p-value < 0.01, * p-value < 0.05 by one sample *t*-Test (H_0: $\mu = 0$, H_a: $\mu \neq 0$) for comparison home versus cabin.
Superscript letters (a,b) indicate significance levels of cabin types by Tukey test for comparison between cabin types.

3.6. Cabin visits and stomach sickness

Most participants (71%) visited their cabin between one and 11 times per year (Supplementary Table S4). A typical stay lasted for two to three days, and the average time spent per year was 28 days (SD = 32). Participants with high-infrastructure cabins spent significantly more days at the cabin ($Mean_{high} = 34$ days) than participants with medium- ($Mean_{medium} = 23$ days) and low-infrastructure cabins ($Mean_{low} = 21$ days) (Supplementary Fig. S3). Moreover, the data indicate that high- and low-infrastructure cabin dwellers more typically stay with their partner than medium-infrastructure cabin dwellers. No significant differences in companionship occurred for children, family, friends, or pets (Supplementary Table S4).

Further, the self-reported incidences of stomach sickness during, or as a result of, a cabin stay were 11% among the 307 respondents who had been to their cabin within the last 12 months and didn't answer "I don't know" regarding stomach sickness. The incidences differed between cabin types, being lower in high-infrastructure cabins (7%) and higher in medium- and low-infrastructure cabins (14% and 17%, respectively) (Supplementary Fig. S4). A logistic regression suggested a significantly higher odds ratio for stomach sickness in medium- (OR = 2.3, 95% CI [1.0, 5.4]) and low-infrastructure cabins (OR = 2.7, 95% CI [1.0, 7.2]) compared to high-infrastructure cabins (Table 4). Corrected for the number of days spent at the cabin in the last 12 months, the incidence rate of stomach sickness in connection to a stay was 4‰ occurrences per day (i.e., 4 occurrences per 1000 days) in the total sample. In the main survey, the general (i.e., not necessarily related to the cabin) estimated rate of stomach sickness in the last 12 months for the same subsample of respondents was 1.3‰ occurrences per day. In comparison, the estimation for non-cabin dweller respondents was 1.0‰ occurrences per day. Across cabin types, the incidence rate was 4.0 times larger in low-infrastructure cabins and 3.1 times larger in medium-infrastructure cabins compared to high-infrastructure cabins.

Table 4
Modelling of stomach sickness in relation to cabin type in logistic regression (high-infrastructure as base level).

Independent variable	Estimate	Std. Error	Z value	p-value	Odds ratio Estimate [95%CI]
Intercept	−2.62	0.31	−8.39		
Medium infrastructure	0.84	0.43	1.97	**0.048**	2.3 [1.0, 5.4]
Low infrastructure	1.01	0.50	2.03	**0.042**	2.7 [1.0, 7.2]

N = 307. Respondents who had not been to the cabin within the last 12 months (n = 20) or had responded "I don't know" (n = 12) were excluded.

4. Discussion

4.1. Cabin types

The analysis of survey data from 339 cabin dwellers resulted in the identification of three cabin types. As respondents were recruited from a national representative consumer sample of 1006 households, we assume a good representativity of cabin dwellers through these 339 answers. Our data indicate that about half of the cabins are high-infrastructure cabins, with a level of facilities and kitchen equipment similar to Norwegian homes. The other half of cabins does not benefit from electricity networks (30%) and/or water networks (39%), most likely due to their location in remote places and older construction dates. Theses cabins rely on alternative energy and water sources (e.g., solar panels, water from a nearby stream). According to our data, ten percent of cabins do not have electricity at all, 18% do not have a refrigerator, and 35% do not have running water in the kitchen. According to the Global Data Lab database, a 40% piped water coverage corresponds to public service facilities in for example Sudan and Vietnam, to urban areas in Niger and Somalia, or to rural areas in Nicaragua and Fiji (Global Data Lab). Likewise, a 70% rate of public services electricity corresponds to the coverage in for example Yemen and Nepal, to urban areas in Sudan and Haiti, or to rural areas in Guatemala and India (Global Data Lab). Note that none of the European and American countries listed in Global Data Lab report similarly low piped water or electricity coverage. Comparably to our results, based on an online survey of over 700 respondents with primary address in the Oslo region Xue et al. (2020) report that the largest category (40%) of non-primary dwellings is high standard (with electricity, water, flush toilet, shower/tub, washing machine, and dishwasher), whereas non-primary dwelling of primitive standard (with outdoor toilet, no running water, no electricity and only sparse insulation) accounts for 29%. These findings confirm our first hypothesis: a wide variation in facilities exists between cabins, ranging from home-like infrastructure and equipment standards to very basic, hut-like standards. Yet, Norwegian consumers are used to unlimited electricity and clean running water access at home (Hyllestad, 2017; Macrotrends, 2022; The World Bank, 2022), which are both very supportive of good hygiene and food safety routines (World Health Organization (WHO), 2006). There is therefore reason to wonder how Norwegian consumers cope with the lack of facilities in cabin environments, and whether this may increase their risk for foodborne illness.

4.2. Kitchen equipment and hygiene practices: cool storage of food

Our data show that half of the cabins do not have any electrical cooling facilities with the highest frequencies in the low-infrastructure cabins. Alternative cooling facilities (e.g., floor hatch or cold basement) have traditionally been used in Norway for food storage until the 1950s, when the refrigerator and freezer made their entrance to the Norwegian households. Approximately half of the cabins in our study have an alternative cooling facility which may compensate for the lack of refrigerator, it is however not known what temperature prevails and how it evolves with seasonal variations. For respondents with cabin refrigerators, fridge temperatures were reported to be very similar at home (4.2 °C) and at the cabin (4.4 °C) on average, and in line with WHO's recommendations to refrigerate all cooked and perishable food preferably below 5 °C (World Health Organization (WHO), 2006), however somewhat above the recommended 0–4 °C from the Norwegian food safety authorities. These reported temperatures are lower than average temperatures measured in refrigerators in other studies. Two earlier Norwegian studies have found an average temperature of 5.6 °C in refrigerators, one performed in 46 households during Christmas and Easter holidays (Røssvoll et al., 2014) and the other in 15 households (Dumitrașcu et al., 2020). In comparison, a large review of 35 studies of refrigerator temperatures from around the world showed an average temperature of 6.1 °C (James et al., 2017). In the present study, no thermometer was provided to the respondents for measuring their refrigerator temperatures. In addition, the respondents could not possibly read temperatures from two different locations simultaneously (home and the cabin) when answering the survey questionnaire. Therefore, the lower self-reported temperatures may be due to thermometer calibration errors or to individual underestimation. On the positive side, this seems to reflect that Norwegian consumers are well informed on what temperature the fridge should be keeping for optimal food preservation.

4.3. Kitchen equipment and hygiene practices: washing practices

A significant proportion of the consumers reported that their handwashing and dishwashing practices are poorer at the cabin than at home, especially in the case of medium- and low-infrastructure cabins. This confirms our second hypothesis: a lower level of hygiene prevails at the cabin compared to home, and at low-infrastructure cabins compared to high-infrastructure cabins. Seen from a scientific point of view, running water is a prerequisite for performing safe handwashing (World Health Organization (WHO), 2006). As far as we know, how sharing the same bowl for handwashing in developed countries affects the risk of infection positively or negatively has not been investigated. However, investigations from developing countries have shown that sharing the same bowl of water for cleaning hands potentially contributes to the spread of pathogens between people rather than being a measure to break the chain of infection (Tetteh-Quarcoo et al., 2016)., Most likely, changing the water in the bowl used for washing each time will reduce the risk of spreading pathogenic microorganisms between persons. However, changing the water in the bowl between each person may be cumbersome when one doesn't have running water and this practice was only reported in 25% of the low-infrastructure cabins. Moreover, a potential transfer of pathogens also when the water is changed between each person has been shown in the context of public restaurants (Enoch & Pius, 2018). From a food safety point of view, more people at medium- and low-infrastructure cabins performed safe dishwashing than safe handwashing. The lack of a dishwasher in these cabins was to some degree compensated with safe washing, rinsing and drying procedures. In particular, the use of hot water when doing the dishes by hand, which is preferred to cold water from a food safety perspective (Mattick et al., 2003), was common in medium- and low-infrastructure cabins. Also, washing up with soap followed by drying will in most cases reduce the level of pathogens sufficiently to prevent contamination of food at next use (Mattick et al., 2003).

4.4. Food consumption practices

Regarding the usage of different types of food at the cabin compared to at home, no comparable data have been found. Our findings indicate that the consumers' choice of foods at the cabin to some degree compensated for potential food safety risks associated to the lack of infrastructure needed for proper hygiene and cooling facilities. For example, a lower consumption of dishes based on foods more often associated with foodborne disease such as raw poultry and soft cheeses, and a higher consumption of canned foods were reported (MacDonald et al., 2015; Skjerdal et al., 2021). Especially medium- and low-infrastructure cabin dwellers decreased their preparation of raw chicken compared to home, which may potentially be explained by food safety concerns. However, very few other differences in choice of foods were observed across cabin infrastructure types, indicating that the motivations behind cabin food choices may be more based on habits, culture, and convenience than on food safety concerns. We may also note that cabin stays may impact healthy eating habits, as all cabin types reported a lower consumption of vegetables (raw or cooked) and a higher consumption of potato chips compared to home. In summary, these findings partially confirm and disconfirm our third hypothesis: a lower consumption of foods associated with foodborne illness prevails at the cabin compared to home, however, our data provide limited evidence of food choice differences in a food safety perspective across cabin infrastructure levels.

4.5. Stomach sickness

About ten percent of respondents reported a case of stomach sickness during or after a stay at the cabin. This number should be interpreted with care. Underreporting may occur as people tend to forget illness, especially if it was limited in severity and time (Cantwell et al., 2010). Over-reporting could occur from illness acquired before going to the cabin (or on the way, e.g., from a road restaurant). Moreover, mostly pathogens with a short incubation time will be connected to the stay at the cabin in the consumer's mind. The responses will reflect infections or intoxications with the most common pathogens (Skjerdal et al., 2021). Therefore, most likely, primarily illness caused by Norovirus and *Campylobacter* (and maybe also *Staphylococcus aureus, Bacillus cereus)* will be reported. Here, one should note that Norovirus infection may be person-to-person transmitted and not acquired from the food, further complicating the interpretation (Lane et al., 2019; Moore et al., 2015). Based on this, the reported illness after a cabin stay will most probably reflect Norovirus acquired from sick persons (including ingestion via food) or from food, and *Campylobacter* contaminated poultry, or water. In addition, one cannot rule out that the self-reported illness is also linked to food stored at too high temperatures, allowing growth and toxin production of other pathogens such as *Staphylococcus aureus* and *Bacillus cereus* (Skjerdal et al., 2021). Food stored at too high temperature is a relevant assumption especially for the 18% of the cabins that did not have a refrigerator. To conclude on these aspects, an in-depth study capturing actual practices in detail would be necessary.

The estimated incidence rate of stomach sickness in the last 12 months was higher in connection to the cabin than in general. Across cabin types, the incidence was four times larger in low-infrastructure cabins and three times larger in medium-infrastructure cabins compared to high-infrastructure cabins. Although these estimates are approximative, these findings seem to confirm our fourth hypothesis: a higher risk of foodborne diseases prevails at the cabin compared to home, and at low-infrastructure cabins compared to high-infrastructure cabins. This can be a result of less safe handwashing and dishwashing practices, storage at unsafe temperatures, and ingestion of contaminated water, reflected by the responses about practices in the survey (Cassivi et al., 2019; MacDonald et al., 2015).

Interestingly, the low-infrastructure group reported higher incidences of stomach sickness despite a significant bias towards higher frequency of professional experience in the health or food sectors. This indicates that food safety knowledge may not be sufficient to compensate for the hygiene challenges one meets in cabins that lack key facilities. Another possible explanation is that these cabin dwellers were better aware of foodborne illness and therefore reported incidences more accurately than the high-infrastructure group. Despite some contradictory results, previous literature investigating the socioeconomic status and incidence of foodborne disease in developed countries have reported a tendency that adults with high socioeconomic status more often acquire disease from *Campylobacter* and *E. coli* than those with low socioeconomic status (Adams et al., 2018; Newman et al., 2015). This has been explained by eating habits (eating out at restaurants, raw meat, fresh foods) and by the finding that fewer people with high socioeconomic status are trained within food preparation and hygiene. The latter is confirmed in our consumer sample, as high-infrastructure cabin dwellers reported significantly higher income and significantly lower professional experience in the health or food sectors, than low-infrastructure cabin dwellers. Corroborating the pattern 'higher income, lower food safety knowledge', we have earlier found that in a home environment, Norwegians with high income consume more high-risk foods and have higher preference for undercooked hamburgers and chicken. On the other hand, they report more safe hygiene practices than lower income groups (Røssvoll et al., 2013). Further, we wondered if infrastructure effects on stomach sickness incidence could be linked to consumer differences with respect to vulnerability to disease. However, our consumer sample showed no systematic differences in risk groups' representation across cabin types.

We also note that in our study, low-infrastructure cabin dwellers reported to having spent 21 days on average at the cabin in the last 12 months, against 34 days for high-infrastructure cabin dwellers. The lower length and frequency of stays in low-infrastructure cabins may be explained by a lower level of comfort, a lower level of convenience in everyday chores, as well as a lower road accessibility. A positive side-effect of this natural time regulation is that spending less time at low-infrastructure cabins may have an important mitigating effect on the increased risk of stomach sickness in such environments.

4.6. Recommendations and future perspectives

The results reported in this study have not previously been documented in Norway and highlight that more attention from food safety authorities should be accorded to the provision of safety advice in cabin environments. Cabins are used very frequently during weekends and vacations, and have been used even more during the COVID-19 pandemic due to home-office possibilities and less travelling abroad (Øye, 2021). In general, cabins with lower infrastructure make it more troublesome to maintain safety and may put cabin dwellers at risk. Knowledge transfer from previous generations on how to cope with daily chores without access to a safe water source, running hot water, a dishwasher, and a refrigerator to preserve foods may play an important role in establishing safe practices. Cabins without water and electricity may compare to hygiene conditions of wilderness backpackers, who have been reported to be commonly subject to gastrointestinal illness (Boulware, 2004). Treatment of water (e.g., boiling), regular handwashing in soapy water, and routine cleaning of cookware in warm soapy water should be recommended to avoid illness. Consumption of safer foods and avoidance of foods with an established higher risk of illness already seems to be common practice in the Norwegian cabin dweller population and should be further encouraged.

More research is needed to disentangle the combined impacts of infrastructure, duration and frequency of stays, hygiene practices, food choices, and household characteristics on the incidence of cabin-related foodborne illness. We recommend that a comprehensive structured questionnaire be developed to fully assess consumer knowledge, practices and attitudes with regard to food safety at the cabin, which may provide complete information to regulatory bodies.

In a broader perspective, this study highlights the role of infrastructure and kitchen facilities on the prevalence of foodborne illness. The results may not only be relevant to other countries with a culture of secondary residences, but also to developing countries showing low infrastructure in the population's primary residences. By contrasting how the same people are more at risk in low-infrastructure environments than in high-structure environments such as Norwegian homes, the study uncovers the role of hygienic and food preparation conditions in food safety at the consumer stage.

4.7. Limitations

The survey questionnaire did not record whether the respondents had access to only one or several cabins. It is therefore unknown whether some respondents combined their answers regarding facilities, practices, and number of days at the cabin across multiple cabins. In the cabin versus home comparison question (Q22 in Appendix 1), it is not clear to what degree consumers considered food safety when answering, however previous questions did place respondents in a food safety perspective. Further, the stomach sickness rate estimates at the cabin and in general were based on slightly different wordings of questions and answer formats. Moreover, their calculation is approximative as occurrences were coded in a binary way (i.e., not taking into account how many times sickness occurred or how many family members were affected), which may especially impact the general estimate. Comparisons are valid, but the actual rates should be interpreted with care. Finally, the data were collected in December 2018. Due to the travelling restrictions in place during the COVID-19 pandemic, cabin sales in Norway increased dramatically in 2020–2021 (Statistics Norway, 2021b). It is unknown whether the pandemic may have modified the cabin dwellers population, cabin visits durations, and/or food and hygiene practices at the cabin in the long term.

5. Conclusion

This paper investigated food safety in cabins versus at home according to levels of cabin infrastructure, and whether consumers adapted their practices to changing environments. Results show that nearly half of the cabin dwellers report cabin facilities of clearly lower standard than home, including 35% without running water in the kitchen and 18% without a refrigerator. The lower standard in cabins leads to adaptive consumer practices regarding cleaning routines and food consumption compared to home. Yet, based on our estimates the incidence rate of stomach sickness was of 4‰ occurrences per day at the cabin against 1.3‰ occurrences per day in general. Corrected for visiting days, the self-reported incidences of stomach sickness in connection to a stay at the cabin was four times larger in low-infrastructure and three times larger in medium-infrastructure cabins than in high-infrastructure cabins. The results highlight a need for information campaigns on the elevated risk for food poisoning and the need to adapt one's hygiene practices in cabin environments, and may be useful to food safety authorities in Norway and other countries with a culture of recreational homes. Future research is recommended to further investigate the link between foodborne illness and consumer practices in medium or low-infrastructure recreational home environments. In a broader perspective, this study highlights how knowledge of the role of infrastructure, hygienic and food preparation conditions in other environments than the home can contribute to a more comprehensive prevention of foodborne illness at the consumer stage.

CRediT authorship contribution statement

V.L. Almli: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **M. Galler:** Validation, Formal analysis, Data curation, Writing – original draft, Visualization. **T. Møretrø:** Conceptualization, Methodology, Writing – original draft, Funding acquisition. **S. Langsrud:** Conceptualization, Methodology, Writing – original draft, Funding acquisition. **M.Ø. Gaarder:** Conceptualization, Methodology, Writing – original draft. **Ø. Ueland:** Conceptualization, Methodology, Writing – original draft.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Acknowledgments

This research was funded by the European Commission H2020 – SFS – 2016–2017: Project no. 727580 SafeConsume. The authors thank Joachim Scholderer for planning and managing the main consumer survey, as well as Silje Elisabeth Skuland and Nina Veflen for useful comments to the questionnaire development on cabins.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodcont.2022.109215.

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