Investigation into the effect of growing food onsite on the incidence of cryptosporidiosis in California Ranching households

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Abstract

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After adjusting for source of drinking water, households that grew more than 50% their food on site were 2.2 times more likely to experience a cryptosporidiosis event each year than those who did not grow more than 50% of food onsite.

1 Introduction

C. parvum is a protozoal parasite that can infect the intestinal tract of over causing cryptosprotidiosis in 70 species, [1] including humans. It is an important human pathogen, with 8,269 cases reported in the USA in 2005, commonly in in patients without normal imune systems, such as the young, old and immunocompromised (e.g. AIDS patients) [2]

Because of the cross infection of *C. parvum*, Cattle are an especially important source of human infection in Calfornia, where there are over 5 million beef and dairy cows. [3] In cattle infection is also mild and commonnly effects calves between ages of 4 days and 4 weeks [**?**]. In beef herds in California, 4% of cattle were found to be shedding *C. parvum* in a recent study, with prevlence among calves less than two months old more than 41 times older animals [4]. Dairy calves are also at risk of *C. parvum* infection, especially due to managment methods commonly used rearing dairy ehifers. The year round precence of young calves in an intensive managment environment allows constant transmisison and constant endemic infection .[5]

Transmission between cattle and humans occurs from direct contact with animal faeces that contain the infections *C. parvum* oocysts[**?**]. The ooccysys are hardy and can survive in the envirnonemnt for some time, depending on environmentla conditions present. During hot dry conditions oocyts survival is reduced, although they may persist for some time if microenvironment (e.g. within moist cow pat) is favourable [6]. Preventiing tranmission of cryptosporidiosis from infected cattle faeces is based on good sanitation and hygiene practices[**?**], although water contamination can occut and was responsible for a large outbreak in miluakee in 1993 [**?**]. *C. parvum* oocycysts hae been located downstream from cattle production facilities and contamination of watersheds is a concern from a human helth persepective [7].

California ranchers and their families are exposed to *C. parvum* oocysts in their work and home environments, with contamination of drinking and recreational water sources been a major source of this exposure. Recreational pursuits common in the ranching community include hiking, fishing, swimmin and water skiing, allp potential sources of exposure to contaminated water. Many california ranching households also have recreational pools to escape the summer heat, and *C parvum* oocysts have been shown to be chlorine resistant, especially in poorly sanitised pools [8]. Ranchers commonly grow their own food, and this may be a source of infection with *C. parvum* oocysts if contaminated water is used for irrigation purposes. No studies we are aware of have investigated the link between contact with contaminated water sources and home food production with cryptosporidiosis.

It was hypothesised that ranchign families experience higher levels of *C. parvum* exposure through direct and indirect contact with cattle faeces, and this esposure is responsible for an increased incidence of cryptosporidiosis in these households.

The objective of this study is to identify risk factors assocaited with cryptosporidiosis in ranching families, by comparing the incidence or cryptosporidiosis in ranching hosueholds with different levels of occumaptional, dietry, and household factors. The study hypothesis for this objective is some ranching families are at higher risk of cryptosporidiosis due to occupational, dietry and household factors.

2 Methods

The study population was ranchers in california The unit of study for this study is the household, and the outcome is incidence of cryptosporidiosis in cases per unit time.

Ranchers were identified from USDA databases as having active ranching operations (sold cattle in state recorded sales in the previous 12 motnhs) This sample (n=1923) was mailed a letter explaining study design and purpose, and a brief return questinoare to expres interest in participting and basic demographic data The high return rate for this initial letter (n= 1704, 88.61 %) demonstrates the willingless of ranchers to participate, and the effectivnenss of previous extension efforts to riase awareness of this important zoonotic disiase. The initial demographic data gathered included household paramaters as listed in table 1, as well as extimated calving start date (CSD).

Based on these inital responses, a local nurse practitioner organised a mutually agreeable time to visit ranching properties, at least 2 months before CSD. For each study area the nurse practitioner was selected from the local bush nursing facility, and where possible preference was given to those that had been in the community for the longest period of time.

During this visit the NP sought to confirm as many of the details collected in the inital questionare as possible, as well as gather information regarding the property layout (were there cattle in close proximity to home block), and determined source of drinking water for each property. At the conclustion of this visit the nurse practitioner also dropped off faeces collection materials and prepaid return envelopes to failitate sample detection in symptomatic individuals. Training was provided in correct sample collection and handling procedures. These samples were mailed to the CAHS lab at UC Davis for IFA and DNA isolation, as described in [9] At the end of the study period, participants were mailed a final questionare regarding GI upsets.

Cases of intestinal discomfort, fever, and diarrhoea were self reported by ranching families, and confimred with IFA and DNA isolation on stool sample to confirm *Cryptosporidium parvum* was the causitaive agent. Study participants names were also searched in local medical databases to detect any cases that went unreported. 15 cases in the exposed group and 18 in the unexposed group were identified in this way.

No matching was undertaken due to the sparsity of study population with respect to predictor variables. Blinding NP was unneccecary as at the time of interview, the case outcome of each family was unknown. Each individuals medical history was examined and any with incidence of severe diarrhoea or other gastrointestinal disease in the last 6 moths was excluded. any Individual with a history of compromised immune system was removed from the study. As the duration of shedding *C. parvum* is typically below one month following infection, it was decided an examination of medical history for past gastrointestinal problems was sufficient for screenign prevalent cases of disease, as individual fecal samples at enrollment would prove too costly and would scare many potential study participants away.

Sample size recquirements were computed using Epi info with alpha of 0.05, desired power of 0.8, biologically signifigant RR of 2, returning a sample size per group of 686 per group, with 10% added for attrition, to return total sample size of 1510. Output can be seen in **??**

Where possible, stocking rates were confirmed by crossreferencing sales records with property registration records

Data quality was maintained throughout the study by using trained professionals for data collection, quereying county medical records to check for missed cases, and using barcoded sample collection containers unique to each household to eliminate mistakes in the lab. IFA tests were calibrated against a gold standard before and after running each batch to ensure consistency.

2.1 Statistical Evaluation

Cox proportional hazard models were used with time to event as response and various covariates discussed above as predictors, with a household level random effect included. The baseline hazard was modified to follow a weibull distribution to reflect the fact that risk for cryptosporidiosis varies with time over the season, with an increased risk occuring with the precence of young calves following calving start date. This model yieldd results as shown in **??** Due to some loss of study households in both case and control groups, Incidence density rates were calculated for all strata of the covariates with findings indicated in **??**.

3 Results

During the study period there were 1042 cases of cryptosporidiosis confirmed by fecal IFA among people who grew more than 50% of their own food, giving an overall incidence density rate of 62 cases per 100 person years. Within the ranching comuunity, there were various risk factors identified for cryptosporidiosis , as listed in **??**. Number of aged people, precence of a pool, slaughtering own meat, eating wild game, size of property, and numbe rof animals were all found to not differ signifigantly between the households that experienced a cryptosporidiosis event and those that did not.

A potential confounder investigated in this study was age. Age of case was recorded and included investigated as it was known children are more likely to become infected with cryptosporidiosis, and are also more likley to be exposed by swimming in contaminated waterways, and practicing sub-standard personal hygien. It was found that IDR for households with young children differed from crude unadjusted IDR, hence the IDR was adjusted for age in the final model.

Interactions that were investigated included source of drinking water and more than half of food grown on site. households that used surface water for drinking and grew more than 50% of food on site were more likely to undergo an episode of cryptosporidiosis, and hence the RR found in final model were adjusted for this interaction.

Sources of possible bias in this study was selection bias and follow up bias. It is possible that there was differential loss to follow up during this study, with ranching families that did not experince a any gastrointestinal event during study period not bothering to report at end of study period. It is also possible that not all cases of GI upset due to cryptosporidiosis were recorded and confirmed. selection bias may have occured as families with a history of GI upset may be more interested in study finding ans hence be more likely to participate. as there is some evidence of immunity following initial episode, this may reduce incidence in exposure group, reducing calculated RR.

4 Discussion

4.1 Strengths and Limitations

Two strengths of the study are the data quality and accuracy of exposure information.

Using a nurse practitioner known to the local community rather than a foriegn researcher improves quality of resposnses by facilitating trust between study participants and data collection point. people are more likely to share true information with someone they see at the postoffice weekly, and in turn the nurse practitioner will already have a wealth of information about local families and ranching properties, and can use judgement when deciding accuary of responses The physical visit by nurse practitioner greatly imporves the accuracy of exposure information. During this visit she was able to inspect and objectively record property layout, water sources, precence of pool on property which imporves the wuality of exposure measures. The use of county medical records to confirm cases where medical attention was sought improves the accuracy of outcome measurement, although the majority of cases were only confirmed through IFA on submitted fecal samples, a demonstration of the average ranchers stoicness and difficulty in accessing medical care in remte rural communities.

Two weaknesses of this study is the loss of some study participants to follow up, and potenital outcome recording issues. There were 126 households lost to follow through this study. They were either unable to be contacted, or refused to participate at the end of the study period. There is the potentail that this was a differentail loss to follow due to the study design. Households that did not experience a cryptosporidiosis event may have thought it unneccecary to record or submit samples, which would have resulted in an over reporting of the relative risk. Ranching households are stronger than the average household, and will be more likely to deal with a mild GI upset than their city counterparts.

5 Figures

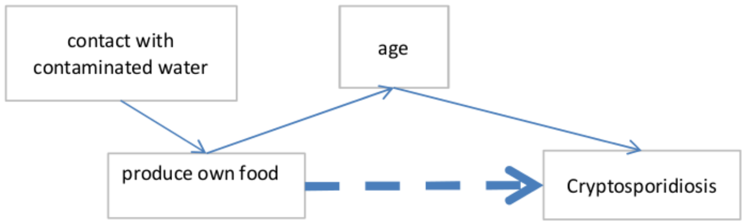


Figure 1: Flow Diagram showing proposed Biological Rationale for study, including exposure, outcome and covariates

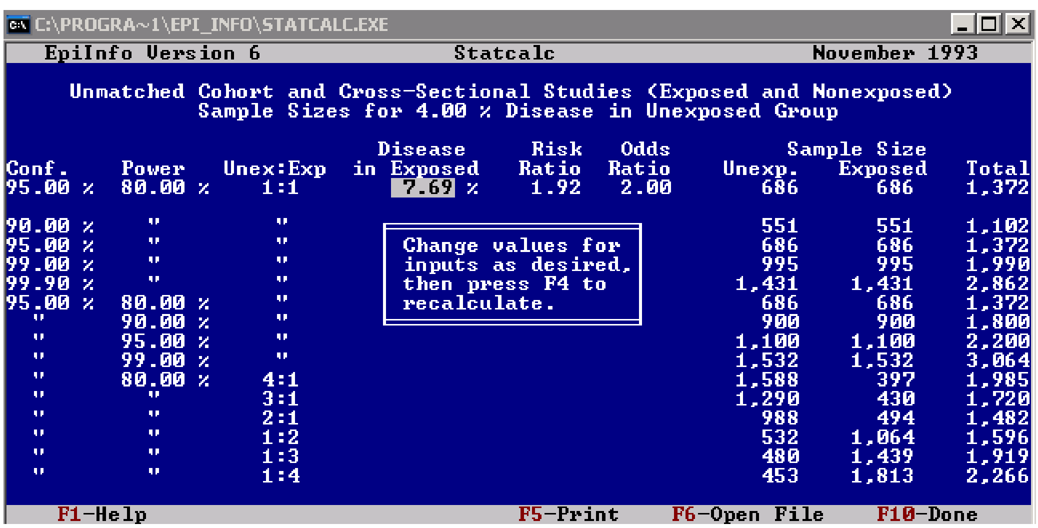
initial ranching operations sent EOI		1923			
return of intial questionaiire		1704	**88.61%** response rate		
number of with NP interview and include in study		1657	**97.24%** response rate		
		* cases are households that experienced a crypto case during study period.			
		Cases		**Controls**	
household	children (<5 yo)	1231	**74.29%**	426	**25.71%**
	number old (>60)	823	**49.67%**	834	**50.33%**
	precence pool	845	**51.00%**	812	**49.00%**
	watersports (water sking, fishing, rafting)	815	**49.19%**	842	**50.81%**
	outdoor recreational pursuits (hiking, hunting)	896	**54.07%**	761	**45.93%**
	Surface water used for drinking	1211	**73.08%**	446	**26.92%**
dietry	grow own vegetables	1343	**81.05%**	314	**18.95%**
	slaughter own meat	873	**52.69%**	784	**47.31%**
	eat wild game	861	**51.96%**	796	**48.04%**
	produce more than 50% of food on property	1042	**62.88%**	615	**37.12%**
occupational	size property	801	**48.34%**	856	**51.66%**
	number animals	873	**52.69%**	784	**47.31%**
	number cow-calf pairs	861	**51.96%**	796	**48.04%**
	stocking rate	1042	**62.88%**	615	**37.12%**
	home block has cattle	1343	**81.05%**	314	**18.95%**

Figure 2: Characteristics of study participants and sample size calculations.

*** cases are households that experienced a crypto case during study period.**

	Cases	Controls	RR	*** adjusted for source drinking water.**
produce >50% of food	678	133	**5.10**	
do not	364	482	**0.76**	
	1042	615		

Figure 3: Odds Ratios (OR) for the association between uveitis and *Bartonella sp.* infection status, age, housing status and geographical location.



C:\PROGRA~1\EPI_INFO\STATCALC.EXE

EpiInfo Version 6 Statcalc November 1993

Unmatched Cohort and Cross-Sectional Studies (Exposed and Nonexposed)
Sample Sizes for 4.00 % Disease in Unexposed Group

Conf.	Power	Unex:Exp	Disease in Exposed	Risk Ratio	Odds Ratio	Sample Size Unexp.	Exposed	Total
95.00 %	80.00 %	1:1	7.69 %	1.92	2.00	686	686	1,372
90.00 %	"	"				551	551	1,102
95.00 %	"	"				686	686	1,372
99.00 %	"	"				995	995	1,990
99.90 %	"	"				1,431	1,431	2,862
95.00 %	80.00 %	"				686	686	1,372
"	90.00 %	"				900	900	1,800
"	95.00 %	"				1,100	1,100	2,200
"	99.00 %	"				1,532	1,532	3,064
"	80.00 %	4:1				1,588	397	1,985
"	"	3:1				1,290	430	1,720
"	"	2:1				988	494	1,482
"	"	1:2				532	1,064	1,596
"	"	1:3				480	1,439	1,919
"	"	1:4				453	1,813	2,266

Change values for inputs as desired, then press F4 to recalculate.

F1-Help F5-Print F6-Open File F10-Done

Figure 4: Sample size function and calculation output from R. Calculations agrees with Epi Info when continuity correction was applied.

References

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