

Social network structure is robust to parasite induced changes in contact behavior

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Supplementary Material

Model description and output

Table. 1 Model formulae for analyses of contact behavior (frequency of contacts, duration of contacts and total duration of contacts) and animal measurements of lambs during the experiment. **Bold indicates terms that were included in the minimal model.**

Model Group	Response	Model Class	Model Family	Fixed Effects	Interactions	Random Effects
Contact Behavior	Frequency of contacts	GLMM	Negative Binomial	Sex	Treatment Group:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Treatment Group:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
	Duration of contacts	GLMM	Negative Binomial	Sex	Treatment Group:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Treatment Group:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
	Total duration of contacts	GLMM	Negative Binomial	Sex	Treatment Group:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Treatment Group:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Phase	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
				Sex	Contact Type:Week	Animal 1 ID + Animal 2 ID + Logger 1 ID + Logger 2 ID + Group ID + Plot
Animal measurements	Pepsinogen	GLMM	Poisson	Sex	Parasitic Status:Week	Animal ID + Plot
				Sex	Treatment Group:Week	Animal ID + Plot
	Weight	GLMM	Gaussian	Sex	Parasitic Status:Week	Animal ID + Plot
				Sex	Treatment Group:Week	Animal ID + Plot
Network metrics	Closeness	LMM	Gaussian	Sex	Parasitic Status:Phase	Logger ID + Plot

Table. 2 Description of fixed and random effects.

Term	Class	Description
Treatment Group	Factor (3 levels)	Non-parasitised (social groups of non-infected lambs); Parasitised (social groups of infected lambs); Mixed (social groups of a mixture of infected and non-infected lambs)
Parasitic Status	Factor (2 levels)	Infected (dosed with parasites); Non-infected (dosed with water)
Contact Type	Factor (3 levels)	Contact between two non-infected animals (non-infected – non-infected), Contact between two infected animals (infected - infected), Contact between one infected and one non-infected animal (infected – non-infected)
Phase	Factor (4 levels)	Pre-parasite (first week of experiment when all lambs were parasite naive); pre-patent (weeks 2-4 when lambs are infected but not shedding eggs); patent-parasite (weeks 5-7 when infected lambs are shedding eggs); post-parasite (weeks 8-9 after lambs are treated with anthelmintic)
Week	Factor (9 levels)	Week of experiment (week 1-9)
Sex	Factor (3 levels)	Male-Male, Female-Female, Male-Female
Individual parasitic status	Factor (5 levels)	Animal.1:Non-infected, Animal.2:Non-infected, Animal.3:Infected, Animal.4:Infected, Animal.5:Non-infected
Animal 1 ID	Factor (60 levels)	ID of Animal 1
Animal 2 ID	Factor (60 levels)	ID of Animal 2
Group ID	Factor (12 levels)	ID of lamb social groups
Plot	Factor (12 levels)	ID of Plot
Logger 1 ID	Factor (65 levels)	ID of Proximity logger worn by Animal 1
Logger 2 ID	Factor (65 levels)	ID of Proximity logger worn by Animal 2

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Table. 3 Model estimates for fixed effects of final generalised linear mixed models on mean serum pepsinogen levels of infected and non-infected lambs during the three blood sampling days during the pre-parasite, patent-parasite and post-parasite phases. AIC values presented from final model. **Bold indicates significant results.**

Fixed effect	Estimate	Std.error	z	p-value
Parasitic status, Infected	-0.05	0.18	-0.29	0.770
Phase, Patent-parasite	0.09	0.09	1.00	0.319
Phase, Post-parasite	0.10	0.12	0.87	0.386
Parasitic status, Infected:Phase, Patent-parasite	0.33	0.14	2.37	0.018
Parasitic status, Infected:Phase, Post-parasite	0.07	0.17	0.43	0.669
(Intercept)	3.01	0.13	22.59	<0.001
AIC = 614.8				

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Table. 4 Model estimates for fixed effects of final generalised linear mixed models on mean weight of the three treatment groups (non-parasitised, parasitised and mixed) during each week of the experiment. AIC values presented from final model. **Bold indicates significant results.**

Fixed effect	Estimate	Std.error	z	p-value
Group, Parasitised	-1.29	1.41	-0.92	0.364
Group, Mixed	0.49	1.41	0.35	0.732
Week, 2	3.17	1.08	2.93	<0.001
Week, 3	2.94	0.70	4.17	<0.001
Week, 4	4.08	1.08	3.77	<0.001
Week, 5	6.79	1.08	6.27	<0.001
Week, 6	6.73	0.70	9.56	<0.001
Week, 7	6.77	1.08	6.26	<0.001
Week, 8	8.06	1.08	7.45	<0.001
Week, 9	8.18	0.70	11.62	<0.001
Week, 10	8.38	1.08	7.75	<0.001
Group, Parasitised:Week, 2	-0.21	1.73	-0.12	0.903
Group, Parasitised:Week, 3	0.89	0.99	0.91	0.366
Group, Parasitised:Week, 4	2.46	1.73	1.42	0.175
Group, Parasitised:Week, 5	-1.42	1.73	-0.82	0.424
Group, Parasitised:Week, 6	-1.32	0.99	-1.33	0.184
Group, Parasitised:Week, 7	0.97	1.73	0.56	0.582
Group, Parasitised:Week, 8	-0.83	1.73	-0.48	0.639
Group, Parasitised:Week, 9	-0.53	0.99	-0.54	0.592
Group, Parasitised:Week, 10	-0.85	1.73	-0.49	0.629
Group, Mixed:Week, 2	-2.98	1.73	-1.72	0.104
Group, Mixed:Week, 3	-0.70	0.99	-0.71	0.479
Group, Mixed:Week, 4	-1.55	1.73	-0.89	0.384
Group, Mixed:Week, 5	-3.43	1.73	-1.98	0.064
Group, Mixed:Week, 6	-1.07	0.99	-1.08	0.281
Group, Mixed:Week, 7	-1.64	1.73	-0.95	0.358
Group, Mixed:Week, 8	-2.77	1.73	-1.60	0.128
Group, Mixed:Week, 9	-1.15	0.99	-1.16	0.245
Group, Mixed:Week, 10	-2.29	1.73	-1.32	0.204
(Intercept)	29.16	1.00	29.17	<0.001
AIC = 2852.044				

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Table. 5 Model estimates for fixed effects of final generalised linear mixed models on mean weight of infected and non-infected lambs during each week of the experiment. AIC values presented from final model. **Bold indicates significant results.**

Fixed effect	Estimate	Std.error	z	p-value
Parasitic status, Infected	-1.07	0.94	-1.14	0.258
Week, 2	1.84	0.56	3.27	<0.001
Week, 3	2.64	0.54	4.85	<0.001
Week, 4	3.56	0.56	6.33	<0.001
Week, 5	5.36	0.56	9.54	<0.001
Week, 6	6.61	0.54	12.13	<0.001
Week, 7	6.99	0.56	12.42	<0.001
Week, 8	7.06	0.56	12.57	<0.001
Week, 9	7.95	0.54	14.60	<0.001
Week, 10	8.14	0.56	14.47	<0.001
Parasitic status, Infected:Week, 2	0.55	0.85	0.65	0.515
Parasitic status, Infected:Week, 3	0.76	0.79	0.96	0.340
Parasitic status, Infected:Week, 4	1.75	0.85	2.06	0.040
Parasitic status, Infected:Week, 5	-0.43	0.85	-0.50	0.615
Parasitic status, Infected:Week, 6	-1.46	0.79	-1.84	0.067
Parasitic status, Infected:Week, 7	-0.95	0.85	-1.12	0.262
Parasitic status, Infected:Week, 8	-0.45	0.85	-0.54	0.592
Parasitic status, Infected:Week, 9	-0.74	0.79	-0.93	0.354
Parasitic status, Infected:Week, 10	-1.74	0.85	-2.06	0.040
(Intercept)	29.40	0.72	40.64	<0.001
AIC = 2845.068				

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Table. 6 Model estimates for fixed effects of final generalised linear mixed models on mean weight of infected lambs in the mixed and single state groups during each week of the experiment. AIC values presented from final model. **Bold indicates significant results.**

Fixed effect	Estimate	Std.error	z	p-value
Group, Mixed	1.03	1.76	0.59	0.562
Week, 2	2.95	1.14	2.60	0.019
Week, 3	3.83	0.73	5.23	<0.001
Week, 4	6.54	1.14	5.75	<0.001
Week, 5	5.37	1.14	4.72	<0.001
Week, 6	5.41	0.73	7.38	<0.001
Week, 7	7.74	1.14	6.81	<0.001
Week, 8	7.23	1.14	6.36	<0.001
Week, 9	7.65	0.73	10.43	<0.001
Week, 10	7.53	1.14	6.62	<0.001
Sex, Male	2.22	1.12	1.98	0.059
Group, Mixed:Week, 2	-2.69	2.04	-1.32	0.201
Group, Mixed:Week, 3	-1.51	1.37	-1.10	0.274
Group, Mixed:Week, 4	-2.51	2.04	-1.23	0.232
Group, Mixed:Week, 5	-2.23	2.04	-1.10	0.286
Group, Mixed:Week, 6	-0.91	1.37	-0.66	0.508
Group, Mixed:Week, 7	-4.19	2.04	-2.06	0.053
Group, Mixed:Week, 8	-2.89	2.04	-1.42	0.171
Group, Mixed:Week, 9	-1.50	1.37	-1.09	0.277
Group, Mixed:Week, 10	-2.17	2.04	-1.06	0.300
(Intercept)	26.99	1.12	24.18	24.18
AIC = 1359.69				

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Table. 7 Effect estimates associated with fixed effects in our models of social contact behavior (frequency, duration and total duration of contacts during each experimental phase) **of each treatment group**. Estimates include the posterior mean, standard error and lower and upper 95% credibility intervals. Estimates are displayed in supplementary Fig 4. DIC values presented from final model. **Bold represent significant estimates (i.e., estimates that did not overlap with zero).**

Fixed Effect	mean	se	lower	mode	upper
Frequency of contacts					
Group, Parasitised	0.097	0.05	-0.001	0.097	0.195
Group, Mixed	0.054	0.05	-0.043	0.054	0.152
Pre-patent	-0.021	0.016	-0.053	-0.021	0.011
Patent-parasite	-0.051	0.017	-0.083	-0.051	-0.018
Post-parasite	-0.105	0.018	-0.14	-0.105	-0.07
Group, Parasitised:Phase, Pre-patent	-0.066	0.023	-0.111	-0.066	-0.021
Group, Parasitised:Phase, Patent-parasite	-0.083	0.023	-0.128	-0.083	-0.038
Group, Parasitised:Phase, Post-parasite	-0.075	0.025	-0.124	-0.075	-0.027
Group, Mixed:Phase, Pre-patent	-0.09	0.023	-0.135	-0.09	-0.046
Group, Mixed:Phase, Patent-parasite	0.015	0.023	-0.03	0.015	0.06
Group, Mixed:Phase, Post-parasite	-0.059	0.025	-0.108	-0.059	-0.01
(Intercept)	0.891	0.062	0.77	0.891	1.012
DIC = 442725.97					
Duration of contacts					
Group, Parasitised	0.001	0.061	-0.119	0.001	0.121
Group, Mixed	0.069	0.061	-0.051	0.069	0.188
Pre-patent	-0.016	0.014	-0.044	-0.016	0.012
Patent-parasite	0.158	0.015	0.129	0.158	0.187
Post-parasite	0.05	0.016	0.019	0.05	0.081
Group, Parasitised:Phase, Pre-patent	0.076	0.02	0.036	0.076	0.116
Group, Parasitised:Phase, Patent-parasite	-0.006	0.02	-0.046	-0.006	0.035
Group, Parasitised:Phase, Post-parasite	-0.044	0.022	-0.087	-0.044	0
Group, Mixed:Phase, Pre-patent	0.002	0.02	-0.037	0.002	0.041
Group, Mixed:Phase, Patent-parasite	-0.001	0.021	-0.041	-0.001	0.039
Group, Mixed:Phase, Post-parasite	0.018	0.022	-0.025	0.018	0.062
(Intercept)	3.22	0.08	3.063	3.22	3.376
DIC = 2681275.01					
Total duration of contacts					
Group, Parasitised	0.086	0.093	-0.098	0.086	0.269
Group, Mixed	0.124	0.093	-0.06	0.124	0.307
Pre-patent	-0.025	0.025	-0.074	-0.025	0.025
Patent-parasite	0.107	0.026	0.056	0.107	0.158
Post-parasite	-0.056	0.028	-0.111	-0.056	-0.002
Group, Parasitised:Phase, Pre-patent	0.008	0.036	-0.063	0.008	0.078
Group, Parasitised:Phase, Patent-parasite	-0.105	0.036	-0.177	-0.105	-0.034
Group, Parasitised:Phase, Post-parasite	-0.122	0.039	-0.198	-0.122	-0.046
Group, Mixed:Phase, Pre-patent	-0.1	0.035	-0.169	-0.1	-0.03
Group, Mixed:Phase, Patent-parasite	0.004	0.036	-0.067	0.004	0.076
Group, Mixed:Phase, Post-parasite	-0.048	0.039	-0.125	-0.048	0.028
(Intercept)	4.074	0.129	3.821	4.075	4.326
DIC = 1212114.24					

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Table. 8 Effect estimates associated with fixed effects in our models of social contact behavior (frequency, duration and total duration of contacts during each experimental week) of each treatment group. Estimates include the posterior mean, standard error and lower and upper 95% credibility intervals. DIC values presented from final model. Estimates are displayed in supplementary Fig 5. **Bold represent significant estimates (i.e., estimates that did not overlap with zero).**

Fixed Effect	mean	se	lower	mode	upper
Frequency of contacts					
Group, Parasitised	0.092	0.05	-0.007	0.092	0.19
Group, Mixed	0.058	0.05	-0.041	0.058	0.156
Week, 2	0.009	0.019	-0.028	0.009	0.047
Week, 3	0.042	0.018	0.006	0.042	0.078
Week, 4	-0.162	0.02	-0.202	-0.162	-0.123
Week, 5	-0.007	0.019	-0.045	-0.007	0.031
Week, 6	-0.14	0.02	-0.18	-0.14	-0.1
Week, 7	-0.035	0.02	-0.073	-0.035	0.004
Week, 8	-0.069	0.02	-0.109	-0.069	-0.029
Week, 9	-0.138	0.02	-0.178	-0.138	-0.098
Group, Parasitised:Week, 2	-0.034	0.028	-0.089	-0.034	0.02
Group, Parasitised:Week, 3	-0.07	0.026	-0.12	-0.07	-0.02
Group, Parasitised:Week, 4	-0.074	0.028	-0.129	-0.074	-0.019
Group, Parasitised:Week, 5	-0.081	0.028	-0.135	-0.081	-0.027
Group, Parasitised:Week, 6	-0.147	0.029	-0.203	-0.147	-0.09
Group, Parasitised:Week, 7	-0.029	0.027	-0.083	-0.029	0.025
Group, Parasitised:Week, 8	-0.12	0.029	-0.178	-0.12	-0.063
Group, Parasitised:Week, 9	-0.035	0.028	-0.09	-0.035	0.02
Group, Mixed:Week, 2	-0.09	0.028	-0.145	-0.09	-0.036
Group, Mixed:Week, 3	-0.105	0.026	-0.155	-0.105	-0.054
Group, Mixed:Week, 4	-0.044	0.028	-0.099	-0.044	0.01
Group, Mixed:Week, 5	-0.009	0.027	-0.062	-0.009	0.045
Group, Mixed:Week, 6	-0.017	0.029	-0.075	-0.017	0.04
Group, Mixed:Week, 7	0.033	0.027	-0.021	0.033	0.086
Group, Mixed:Week, 8	-0.083	0.029	-0.141	-0.083	-0.026
Group, Mixed:Week, 9	-0.048	0.029	-0.105	-0.048	0.008
(Intercept)	0.889	0.062	0.767	0.889	1.011
DIC = 442036.74					
Duration of contacts					
Group, Parasitised	-0.043	0.017	-0.076	-0.043	-0.009
Group, Mixed	0.039	0.016	0.007	0.039	0.071
Week, 2	-0.12	0.018	-0.155	-0.12	-0.084
Week, 3	0.101	0.017	0.067	0.101	0.135
Week, 4	0.093	0.018	0.058	0.093	0.128
Week, 5	0.236	0.018	0.202	0.236	0.271
Week, 6	0.056	0.018	0.019	0.056	0.092
Week, 7	0.031	0.018	-0.004	0.031	0.067
Week, 8	-0.021	0.061	-0.141	-0.021	0.1
Week, 9	0.058	0.061	-0.062	0.058	0.178
Group, Parasitised:Week, 2	0.175	0.025	0.126	0.175	0.223
Group, Parasitised:Week, 3	0.043	0.023	-0.001	0.043	0.088
Group, Parasitised:Week, 4	0.085	0.025	0.036	0.085	0.135
Group, Parasitised:Week, 5	0.07	0.024	0.023	0.07	0.118
Group, Parasitised:Week, 6	-0.047	0.026	-0.098	-0.047	0.003
Group, Parasitised:Week, 7	-0.011	0.025	-0.059	-0.011	0.037
Group, Parasitised:Week, 8	-0.035	0.026	-0.086	-0.035	0.017
Group, Parasitised:Week, 9	-0.025	0.025	-0.074	-0.025	0.024
Group, Mixed:Week, 2	-0.005	0.024	-0.053	-0.005	0.043
Group, Mixed:Week, 3	0.012	0.023	-0.033	0.012	0.057
Group, Mixed:Week, 4	0.066	0.025	0.017	0.066	0.115
Group, Mixed:Week, 5	0.036	0.024	-0.011	0.036	0.084
Group, Mixed:Week, 6	-0.065	0.026	-0.115	-0.065	-0.014

Group, Mixed:Week, 7	0.003	0.024	-0.046	0.003	0.051
Group, Mixed:Week, 8	0.064	0.027	0.012	0.064	0.116
Group, Mixed:Week, 9	-0.024	0.026	-0.074	-0.024	0.027
(Intercept)	3.23	0.08	3.072	3.23	3.387
DIC = 2680637.43					
Total duration of contacts					
Group, Parasitised	-0.016	0.03	-0.075	-0.016	0.043
Group, Mixed	0.097	0.029	0.04	0.097	0.154
Week, 2	-0.272	0.031	-0.333	-0.272	-0.212
Week, 3	0.094	0.03	0.034	0.094	0.153
Week, 4	-0.037	0.031	-0.098	-0.037	0.024
Week, 5	0.192	0.031	0.131	0.192	0.253
Week, 6	-0.018	0.032	-0.081	-0.018	0.045
Week, 7	-0.11	0.031	-0.171	-0.11	-0.048
Week, 8	0.061	0.094	-0.124	0.061	0.246
Week, 9	0.116	0.094	-0.069	0.116	0.301
Group, Parasitised:Week, 2	0.11	0.044	0.024	0.11	0.196
Group, Parasitised:Week, 3	-0.026	0.04	-0.105	-0.026	0.053
Group, Parasitised:Week, 4	0.028	0.043	-0.057	0.028	0.113
Group, Parasitised:Week, 5	-0.028	0.043	-0.113	-0.028	0.056
Group, Parasitised:Week, 6	-0.201	0.044	-0.287	-0.201	-0.114
Group, Parasitised:Week, 7	-0.058	0.044	-0.144	-0.058	0.028
Group, Parasitised:Week, 8	-0.151	0.046	-0.241	-0.151	-0.061
Group, Parasitised:Week, 9	-0.066	0.043	-0.151	-0.066	0.019
Group, Mixed:Week, 2	-0.114	0.043	-0.199	-0.114	-0.029
Group, Mixed:Week, 3	-0.113	0.04	-0.192	-0.113	-0.034
Group, Mixed:Week, 4	0.017	0.043	-0.066	0.017	0.101
Group, Mixed:Week, 5	0.023	0.043	-0.061	0.023	0.107
Group, Mixed:Week, 6	-0.094	0.045	-0.182	-0.094	-0.006
Group, Mixed:Week, 7	0.041	0.044	-0.045	0.041	0.127
Group, Mixed:Week, 8	-0.021	0.046	-0.111	-0.021	0.069
Group, Mixed:Week, 9	-0.08	0.044	-0.167	-0.08	0.007
(Intercept)	4.081	0.129	3.826	4.082	4.335
DIC = 1211285.71					

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Table. 9 Effect estimates associated with fixed effects in our models of social contact behavior (frequency, duration and total duration of contacts during each experimental phase) of lambs in the **mixed-parasitic state groups**. Estimates include the posterior mean, standard error and lower and upper 95% credibility intervals. DIC values presented from final model. Estimates are displayed in supplementary Fig 6. **Bold represent significant estimates (i.e., estimates that did not overlap with zero).**

Fixed Effect	mean	se	lower	mode	upper
Frequency of contacts					
Contact type, Infected - Infected	0.068	0.08	-0.09	0.068	0.226
Contact type, Non-infected - Infected	0.05	0.042	-0.033	0.05	0.132
Phase, Pre-patent	-0.025	0.03	-0.083	-0.025	0.034
Phase, Patent-parasite	0.02	0.03	-0.039	0.02	0.078
Phase, Post-parasite	-0.048	0.033	-0.112	-0.048	0.016
Contact type, Infected - Infected:Phase, Pre-patent	-0.231	0.061	-0.35	-0.231	-0.112
Contact type, Infected - Infected:Phase, Patent-parasite	-0.117	0.06	-0.235	-0.117	0
Contact type, Infected - Infected:Phase, Post-parasite	-0.328	0.07	-0.464	-0.328	-0.192
Contact type, Non-infected - Infected:Phase, Pre-patent	-0.032	0.034	-0.098	-0.032	0.034
Contact type, Non-infected - Infected:Phase, Patent-parasite	-0.046	0.034	-0.112	-0.046	0.02
Contact type, Non-infected - Infected:Phase, Post-parasite	-0.1	0.038	-0.174	-0.1	-0.026
(Intercept)	0.812	0.08	0.653	0.813	0.969
DIC = 144682.48					
Duration of contacts					
Contact type, Infected - Infected	-0.024	0.096	-0.214	-0.024	0.167
Contact type, Non-infected - Infected	-0.004	0.049	-0.102	-0.004	0.094
Phase, Pre-patent	-0.01	0.027	-0.063	-0.01	0.042
Phase, Patent-parasite	0.038	0.026	-0.014	0.038	0.09
Phase, Post-parasite	0.001	0.029	-0.056	0.001	0.058
Contact type, Infected - Infected:Phase, Pre-patent	0	0.03	-0.059	0	0.059
Contact type, Infected - Infected:Phase, Patent-parasite	0.106	0.03	0.048	0.106	0.164
Contact type, Infected - Infected:Phase, Post-parasite	0.055	0.034	-0.011	0.055	0.121
Contact type, Non-infected - Infected:Phase, Pre-patent	-0.053	0.054	-0.159	-0.053	0.053
Contact type, Non-infected - Infected:Phase, Patent-parasite	0.133	0.053	0.028	0.133	0.237
Contact type, Non-infected - Infected:Phase, Post-parasite	-0.108	0.063	-0.231	-0.108	0.016
(Intercept)	3.34	0.086	3.171	3.34	3.508
DIC = 881057.56					
Total duration of contacts					
Contact type, Infected - Infected	-0.019	0.156	-0.328	-0.02	0.289
Contact type, Non-infected - Infected	0.039	0.081	-0.121	0.039	0.198
Phase, Pre-patent	-0.035	0.047	-0.127	-0.035	0.057
Phase, Patent-parasite	0.053	0.047	-0.04	0.053	0.145
Phase, Post-parasite	-0.085	0.051	-0.186	-0.085	0.014
Sex, (Male-Female)	-0.215	0.094	-0.401	-0.214	-0.03
Sex, (Male-Male)	0.059	0.095	-0.127	0.06	0.244
Contact type, Infected - Infected:Phase, Pre-patent	-0.361	0.106	-0.57	-0.361	-0.153
Contact type, Infected - Infected:Phase, Patent-parasite	-0.031	0.053	-0.135	-0.031	0.074
Contact type, Infected - Infected:Phase, Post-parasite	0.064	0.053	-0.041	0.064	0.169
Contact type, Non-infected - Infected:Phase, Pre-patent	-0.015	0.059	-0.131	-0.015	0.101
Contact type, Non-infected - Infected:Phase, Patent-parasite	-0.019	0.156	-0.328	-0.02	0.289
Contact type, Non-infected - Infected:Phase, Post-parasite	0.039	0.081	-0.121	0.039	0.198
(Intercept)	4.177	0.14	3.9	4.178	4.453
DIC = 398092.26					

Table. 10 Effect estimates associated with fixed effects in our models of social contact behavior (frequency, duration and total duration of contacts during each experimental week) of lambs in the **mixed-parasitic state groups**. Estimates include the posterior mean, standard error and lower and upper 95% credibility intervals. DIC values presented from final model. Estimates are displayed in supplementary Fig 7. **Bold represent significant estimates (i.e., estimates that did not overlap with zero).**

Fixed Effect	mean	se	lower	mode	upper
Frequency of contacts					
Contact type, Infected - Infected	0.042	0.039	-0.034	0.042	0.117
Contact type, Non-infected - Infected	0.017	0.035	-0.052	0.017	0.086
Week, 2	-0.116	0.036	-0.186	-0.116	-0.046
Week, 3	0	0.036	-0.071	0	0.07
Week, 4	-0.128	0.04	-0.206	-0.128	-0.05
Week, 5	0.146	0.036	0.076	0.146	0.216
Week, 6	-0.045	0.039	-0.122	-0.045	0.032
Week, 7	-0.022	0.037	-0.096	-0.022	0.051
Week, 8	0.077	0.084	-0.09	0.077	0.243
Week, 9	0.053	0.044	-0.034	0.053	0.14
Contact type, Infected - Infected:Week, 2	-0.14	0.075	-0.288	-0.14	0.007
Contact type, Infected - Infected:Week, 3	-0.268	0.071	-0.407	-0.268	-0.128
Contact type, Infected - Infected:Week, 4	-0.31	0.077	-0.461	-0.31	-0.16
Contact type, Infected - Infected:Week, 5	-0.027	0.069	-0.163	-0.027	0.109
Contact type, Infected - Infected:Week, 6	-0.071	0.086	-0.24	-0.071	0.099
Contact type, Infected - Infected:Week, 7	-0.276	0.07	-0.413	-0.276	-0.139
Contact type, Infected - Infected:Week, 8	-0.329	0.079	-0.483	-0.329	-0.175
Contact type, Infected - Infected:Week, 9	-0.361	0.089	-0.537	-0.361	-0.187
Contact type, Non-infected - Infected:Week, 2	-0.031	0.043	-0.115	-0.031	0.053
Contact type, Non-infected - Infected:Week, 3	-0.025	0.041	-0.105	-0.025	0.055
Contact type, Non-infected - Infected:Week, 4	-0.05	0.041	-0.131	-0.05	0.03
Contact type, Non-infected - Infected:Week, 5	0.004	0.04	-0.075	0.004	0.083
Contact type, Non-infected - Infected:Week, 6	0.048	0.047	-0.044	0.048	0.139
Contact type, Non-infected - Infected:Week, 7	-0.163	0.04	-0.241	-0.163	-0.084
Contact type, Non-infected - Infected:Week, 8	-0.081	0.044	-0.168	-0.081	0.005
Contact type, Non-infected - Infected:Week, 9	-0.139	0.045	-0.227	-0.139	-0.051
(Intercept)	0.859	0.074	0.713	0.859	1.005
DIC = 144528.22					
Duration of contacts					
Contact type, Infected - Infected	-0.015	0.101	-0.215	-0.015	0.185
Contact type, Non-infected - Infected	-0.003	0.052	-0.105	-0.003	0.1
Week, 2	-0.029	0.035	-0.097	-0.029	0.039
Week, 3	0.064	0.032	0.002	0.064	0.127
Week, 4	-0.068	0.032	-0.131	-0.068	-0.005
Week, 5	-0.019	0.032	-0.082	-0.019	0.043
Week, 6	-0.102	0.036	-0.172	-0.102	-0.032
Week, 7	0.17	0.031	0.109	0.17	0.231
Week, 8	0.007	0.035	-0.063	0.007	0.077
Week, 9	0.037	0.034	-0.028	0.037	0.103
Contact type, Infected - Infected:Week, 2	0.016	0.066	-0.115	0.016	0.146
Contact type, Infected - Infected:Week, 3	-0.109	0.064	-0.235	-0.109	0.016
Contact type, Infected - Infected:Week, 4	-0.081	0.07	-0.219	-0.081	0.057
Contact type, Infected - Infected:Week, 5	0.17	0.061	0.049	0.17	0.29
Contact type, Infected - Infected:Week, 6	0.203	0.078	0.051	0.202	0.355
Contact type, Infected - Infected:Week, 7	0.074	0.062	-0.047	0.074	0.195
Contact type, Infected - Infected:Week, 8	-0.01	0.071	-0.15	-0.01	0.13
Contact type, Infected - Infected:Week, 9	-0.374	0.082	-0.534	-0.374	-0.212
Contact type, Non-infected - Infected:Week, 2	0.009	0.038	-0.066	0.009	0.085
Contact type, Non-infected - Infected:Week, 3	-0.021	0.037	-0.093	-0.021	0.051
Contact type, Non-infected - Infected:Week, 4	0.024	0.037	-0.049	0.024	0.096
Contact type, Non-infected - Infected:Week, 5	0.188	0.035	0.118	0.188	0.257
Contact type, Non-infected - Infected:Week, 6	0.164	0.042	0.082	0.164	0.246
Contact type, Non-infected - Infected:Week, 7	0.022	0.035	-0.046	0.022	0.091
Contact type, Non-infected - Infected:Week, 8	0.174	0.039	0.096	0.174	0.251

Contact type, Non-infected - Infected:Week, 9	-0.128	0.04	-0.207	-0.128	-0.049
(Intercept)	3.332	0.088	3.159	3.332	3.505
DIC = 880800.11					
Total duration of contacts					
Contact type, Infected - Infected	0.006	0.157	-0.303	0.006	0.316
Contact type, Non-infected - Infected	0.048	0.081	-0.112	0.048	0.208
Week, 2	0.016	0.061	-0.103	0.016	0.135
Week, 3	0.071	0.056	-0.038	0.071	0.18
Week, 4	-0.178	0.056	-0.287	-0.178	-0.069
Week, 5	0.02	0.057	-0.091	0.02	0.132
Week, 6	-0.253	0.061	-0.372	-0.253	-0.134
Week, 7	0.294	0.057	0.183	0.294	0.405
Week, 8	-0.101	0.062	-0.222	-0.101	0.02
Week, 9	0.012	0.059	-0.103	0.012	0.127
Contact type, Infected - Infected:Week, 2	-0.06	0.117	-0.291	-0.06	0.17
Contact type, Infected - Infected:Week, 3	-0.287	0.11	-0.503	-0.287	-0.072
Contact type, Infected - Infected:Week, 4	-0.322	0.115	-0.549	-0.322	-0.096
Contact type, Infected - Infected:Week, 5	0.168	0.11	-0.048	0.168	0.383
Contact type, Infected - Infected:Week, 6	0.228	0.131	-0.028	0.227	0.485
Contact type, Infected - Infected:Week, 7	-0.182	0.111	-0.401	-0.182	0.036
Contact type, Infected - Infected:Week, 8	-0.244	0.119	-0.478	-0.244	-0.01
Contact type, Infected - Infected:Week, 9	-0.677	0.132	-0.936	-0.678	-0.417
Contact type, Non-infected - Infected:Week, 2	-0.02	0.067	-0.153	-0.02	0.112
Contact type, Non-infected - Infected:Week, 3	-0.037	0.064	-0.163	-0.037	0.089
Contact type, Non-infected - Infected:Week, 4	-0.035	0.064	-0.161	-0.035	0.091
Contact type, Non-infected - Infected:Week, 5	0.151	0.064	0.026	0.151	0.275
Contact type, Non-infected - Infected:Week, 6	0.221	0.072	0.08	0.221	0.361
Contact type, Non-infected - Infected:Week, 7	-0.114	0.064	-0.24	-0.114	0.012
Contact type, Non-infected - Infected:Week, 8	0.149	0.069	0.014	0.149	0.284
Contact type, Non-infected - Infected:Week, 9	-0.274	0.07	-0.412	-0.274	-0.136
(Intercept)	4.157	0.141	3.878	4.158	4.435
DIC = 397836.83					

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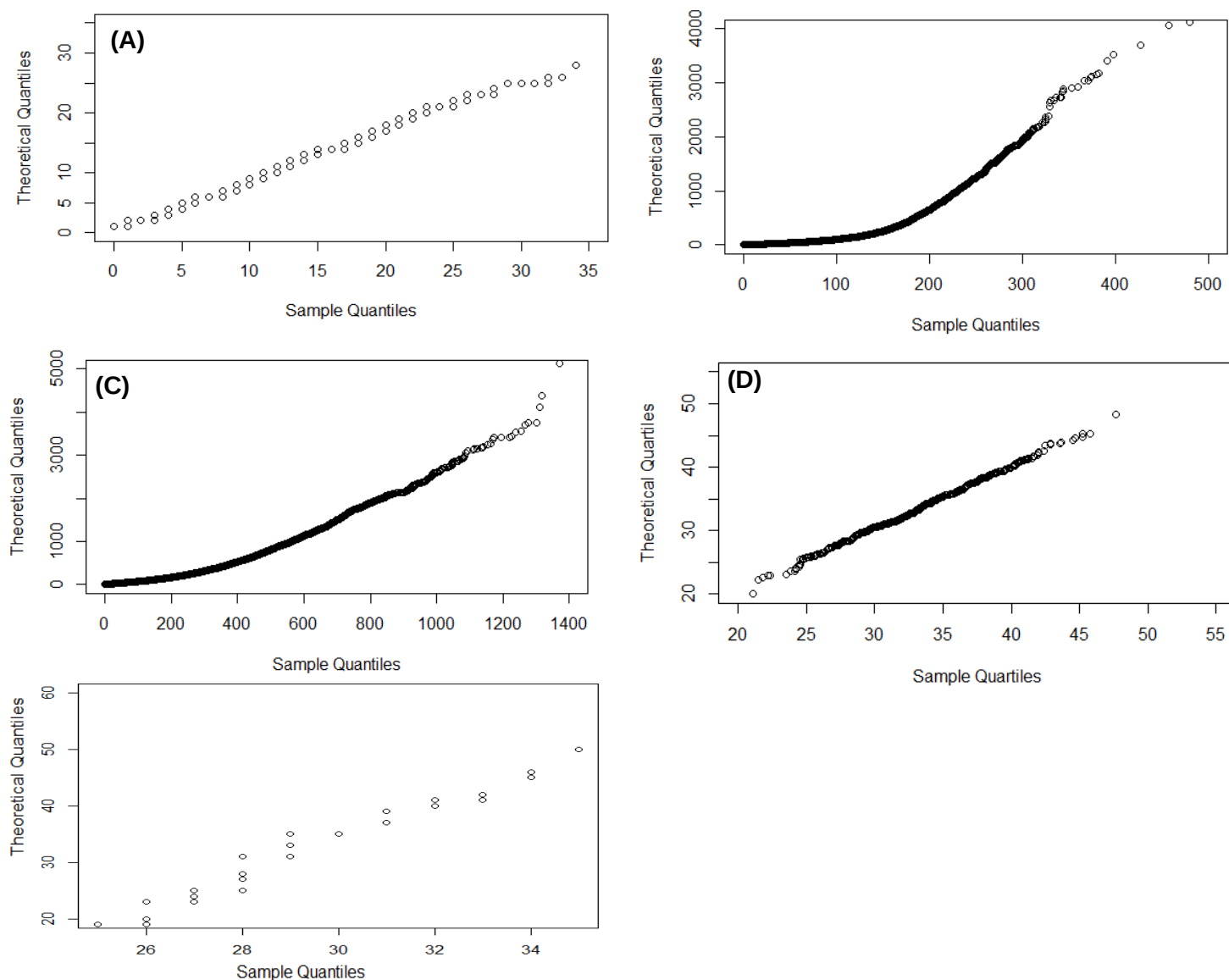
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86 Additional Figures

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89 **Fig. 1** Quantile-quantile plots showing the empirically observed quantiles of **(A)** frequency of
 90 contacts **(B)** duration of contacts and **(C)** total duration of contacts as a function of quantiles
 91 expected from a negative binomial distribution. **(D)** weight as a function of quantiles from a
 92 Gaussian distribution. **(E)** serum pepsinogen as a function of quantiles from a Poisson
 93 distribution.

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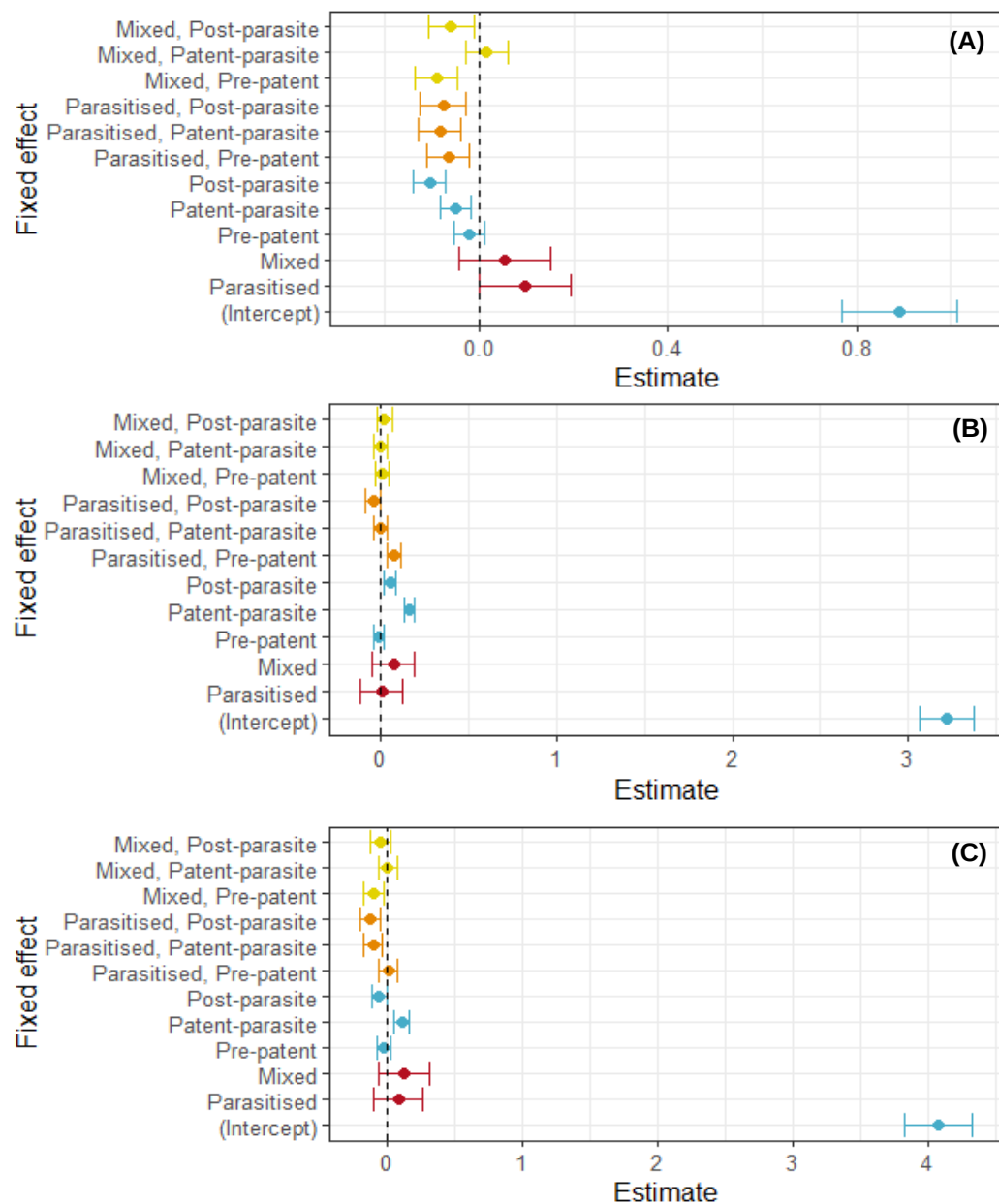


Fig. 2 Comparison of the fixed effect estimates from each response variable model fitted on **all data**. Points denote the mean effect estimate and bars represent the 0.025 and 0.975 quantiles. Plot **(A)** denotes the estimates from the frequency model including Treatment group x Phase interaction effect. Plot **(B)** denotes the estimates from the duration model including Treatment group x Phase interaction effect. Points of different colours denote the results from different levels of the explanatory variables. Plot **(C)** denotes the estimates from the total duration model including Treatment group x Phase interaction effect. Points of different colours denote the results from different levels of the explanatory variables.

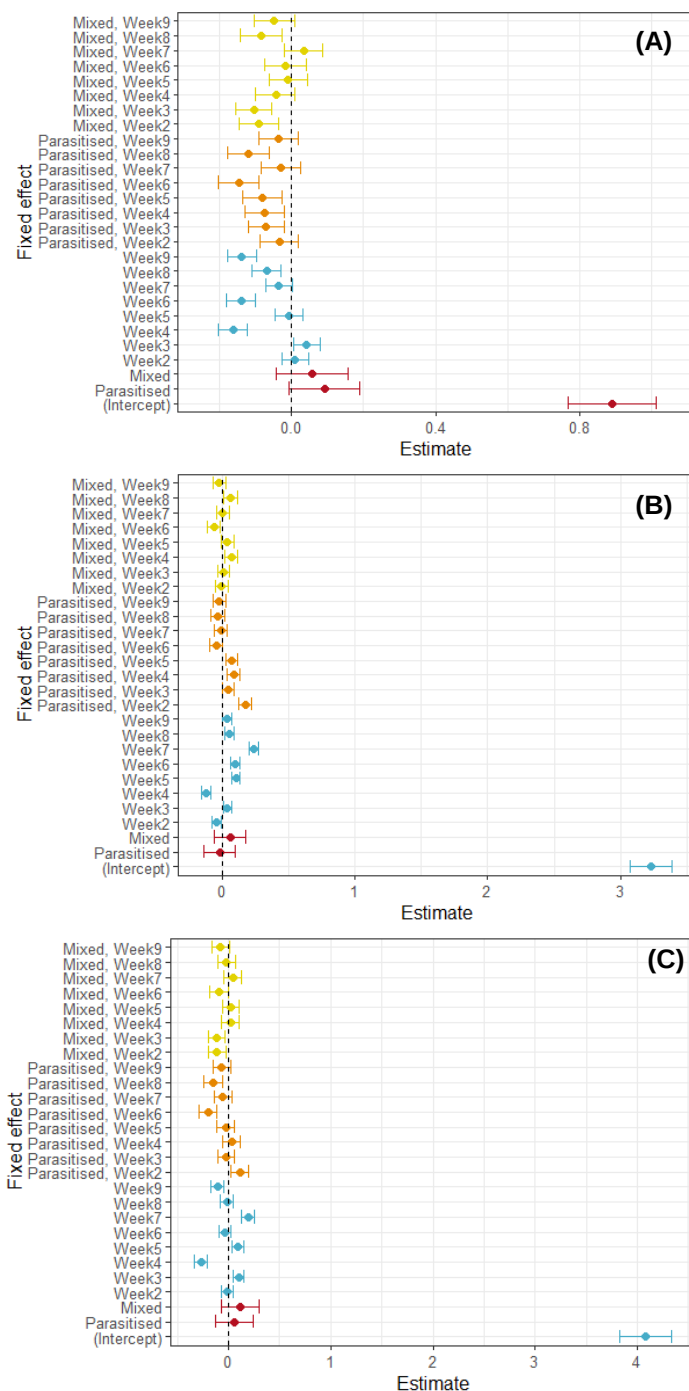
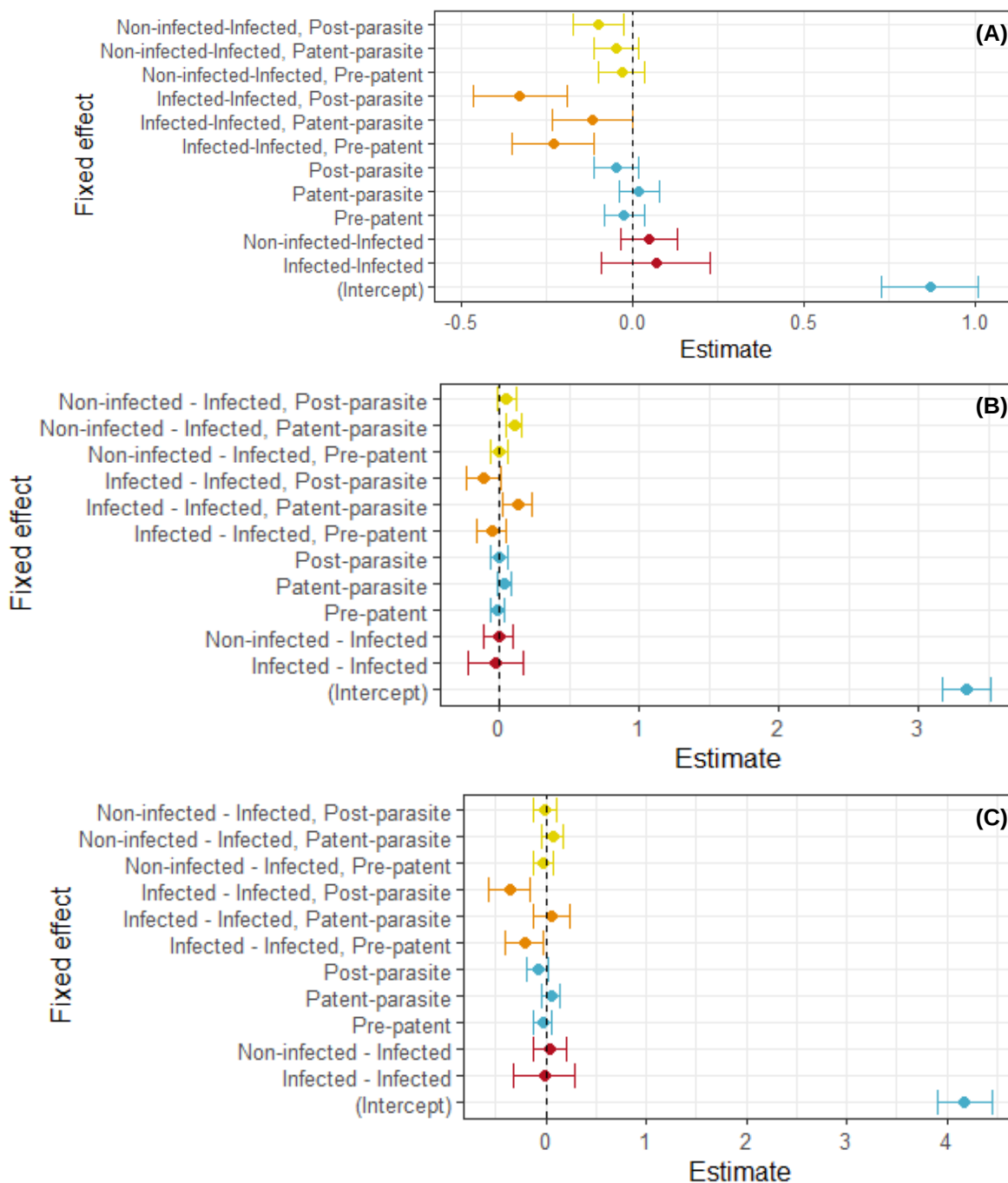


Fig. 3 Comparison of the fixed effect estimates from each response variable model fitted on all data. Points denote the mean effect estimate and bars represent the 0.025 and 0.975 quantiles. Plot **(A)** denotes the estimates from the frequency model including Treatment group x Week interaction effect. Plot **(B)** denotes the estimates from the duration model including Treatment group x Week interaction effect. Points of different colours denote the results from different levels of the explanatory variables. Plot **(C)** denotes the estimates from the total duration model including Treatment group x Week interaction effect. Points of different colours denote the results from different levels of the explanatory variables.



117 **Fig. 4** Comparison of the fixed effect estimates from each response variable model fitted on
 118 **mixed group data only**. Points denote the mean effect estimate and bars represent the
 119 0.025 and 0.975 quantiles. Plot **(A)** denotes the estimates from the frequency model
 120 including Contact type x Phase interaction effect and Plot **(B)** denotes the estimates from the
 121 duration model including Contact type x Phase interaction effect and Plot **(C)** denotes the
 122 estimates from the total duration model including Contact type x Phase interaction effect.

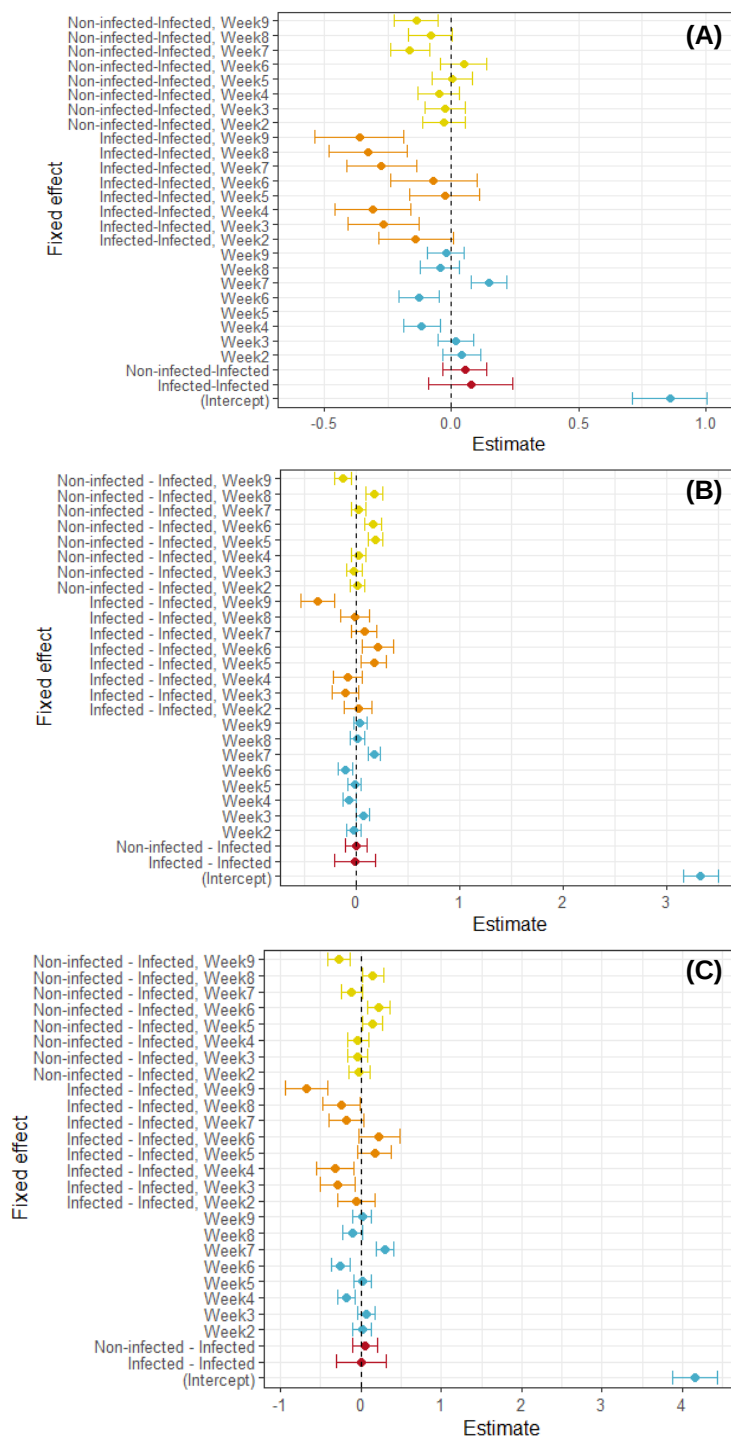


Fig. 5 Comparison of the fixed effect estimates from each response variable model fitted on **mixed group data only**. Points denote the mean effect estimate and bars represent the 0.025 and 0.975 quantiles. Plot **(A)** denotes the estimates from the frequency model including Contact type x Week interaction effect and Plot **(B)** denotes the estimates from the duration model including Contact type x Week interaction effect and Plot **(C)** denotes the estimates from the total duration model including Contact type x Week interaction effect.

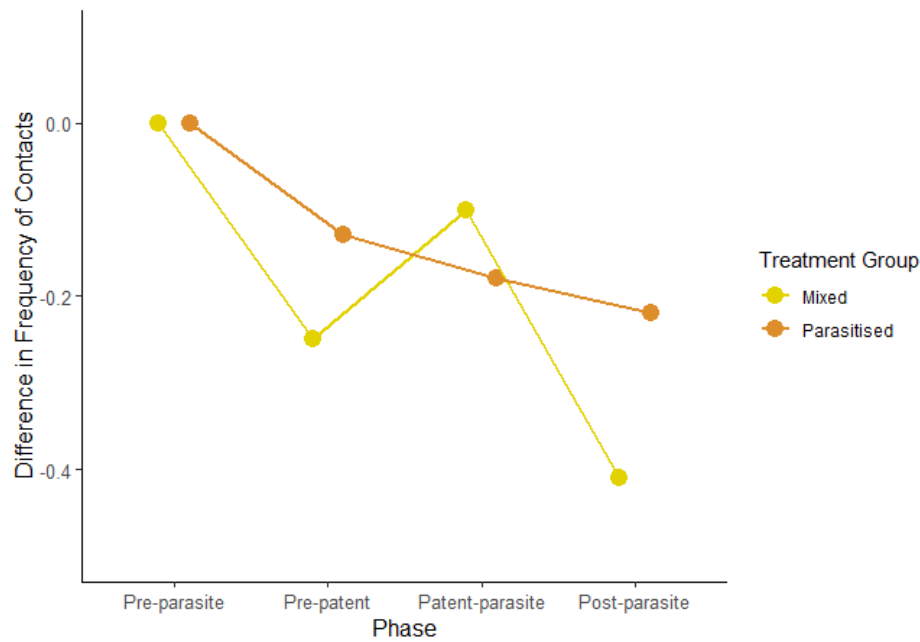


Fig. 6 Difference in frequency of contacts between infected animals in the mixed groups and animals in the parasitised groups during each phase of the study compared to the pre-parasite phase (week 1). Colours denote the group type (yellow: mixed group and orange: parasitised group).