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NOTES AND COMMENTS

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Honey bee colony loss rates in 37 countries using the COLOSS survey for winter 2019–2020: the combined effects of operation size, migration and queen replacement

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ABSTRACT

This article presents managed honey bee colony loss rates over winter 2019/20 resulting from using the standardised COLOSS questionnaire in 37 countries. Six countries were from outside Europe, including, for the first time in this series of articles, New Zealand. The 30,491 beekeepers outside New Zealand reported 4.5% of colonies with unsolvable queen problems, 11.1% of colonies dead after winter and 2.6% lost through natural disaster. This gave an overall colony winter loss rate of 18.1%, higher than in the previous year. The winter loss rates varied greatly between countries, from 7.4% to 36.5%. 3216 beekeepers from New Zealand managing 297,345 colonies reported 10.5% losses for their 2019 winter (six months earlier than for other, Northern Hemisphere, countries). We modelled the risk of loss as a dead/empty colony or from unresolvable queen problems, for all countries except New Zealand. Overall, larger beekeeping operations with more than 50 colonies experienced significantly lower losses ($p < 0.001$). Migration was also highly significant ($p < 0.001$), with lower loss rates for operations migrating their colonies in the previous season. A higher proportion of new queens reduced the risk of colony winter loss ($p < 0.001$), suggesting that more queen replacement is better. All three factors, operation size, migration and proportion of young queens, were also included in a multivariable main effects quasi-binomial GLM and all three remained highly significant ($p < 0.001$). Detailed results for each country and overall are given in a table, and a map shows relative risks of winter loss at the regional level.

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This article presents results on managed honey bee colony winter loss rates in 37 countries for winter 2019/2020, updating a recent series of such reports from national surveys of beekeepers in the countries participating in the ongoing COLOSS core project on "monitoring honey bee colony losses" (Brodschneider et al., 2022). Each country taking part organises its own means of contacting beekeepers but uses a standardised questionnaire (van der Zee et al., 2013), to give comparability of results. Observational data are collected at the beekeeping operation level, not colony or apiary level, in an annual spring survey covering the immediately preceding winter. The previous short reports are available in Brodschneider et al. (2016, 2018) and Gray et al. (2019, 2020). Over time, the number of participating countries represented in these surveys has gradually increased to its present level; for example, 29 countries took part in the survey in 2016 (Brodschneider et al., 2016). New countries are peer-mentored in survey organisation, data collection and coding of collected data, especially where conditions for conducting a survey are challenging, and ongoing efforts are made to expand the network as well as to encourage increased and representative data collection in countries already participating.

While there was some anticipation of beekeeper responses or opportunities to contact beekeepers being adversely affected by limitations on beekeepers and beekeeper activities caused by Covid-19 restrictions in the spring of 2020, the response rates held up relatively well. Croatia, which has reliably participated in monitoring over many years, found that the lack of beekeeper meetings made data collection sufficiently difficult that they were unable to take part this time. Difficulties were also experienced in Malta, which could only return a few responses. However, many countries are now mostly or only using an online survey, this methodology proved to be more robust to social limitations, and in general sample sizes compared well to those of the 2019 survey. For the countries participating in the survey in spring 2019, the percentage change in their response between that survey and the spring 2020 survey ranged from −100% (for Croatia) to +225% (for France, which more than tripled its response, from 317 valid responses to 1029), with an average change of +26% and a typical (median) change of about +6%, a moderate increase. Three new countries also joined. Romania took part for the first time in the spring 2020 survey, and after an absence of several years, Egypt joined Algeria, Iran, Israel, and Mexico as participating countries outside of Europe. Additionally, for the first time in our international study, winter loss rates are reported here for New Zealand (Brown et al. (2018) give details of the New Zealand survey).

As is standard in these studies, careful data quality checks are carried out on colony loss data returned by each participating country for central processing (Brodschneider et al., 2018). Each beekeeper is asked to state the number of colonies going into winter, how many of these colonies (a) were alive after winter but had unsolvable queen problems (e.g., a missing queen, laying workers, or a drone-egg laying queen), (b) were dead after winter or were reduced to just a few hundred bees (an empty hive), and (c) were lost over winter to natural disaster (flooding, fire, etc., the various possible causes depending on country conditions). The overall proportion of colonies lost is found as the sum given by $(a + b + c)$, divided by the number of colonies going into winter. Responses failing the data checks are excluded, however, this rate of response exclusion is now very low. For the data returned in the survey of 2020 from 33,821 beekeepers, just 0.3% of responses were discarded as inconsistent or otherwise unsuitable for loss calculations. The remaining 99.7% of results reported here represent 33,707 beekeepers, who managed 1,134,426 colonies in total before winter. This continues the trend of increased numbers of beekeepers and colonies observed in these surveys, as well as increasing numbers of countries. For comparison, in the 2019 survey 28,629 beekeepers supplied useable colony loss data on 738,233 colonies going into winter, from two fewer countries.

Table 1 shows winter loss rates for each country and over all countries. These calculations and other results shown were obtained using the R software (R Core Team, 2019; van der Zee et al., 2013). As a Southern-Hemisphere country, New Zealand's winter is six months ahead or behind those of the other countries here. We report results for winter in New Zealand in 2019, surveyed in August-October 2019 rather than in spring 2020 as for the other countries. As the timing of winter is different, the results for New Zealand are not included in the overall loss rates and modelling of risk factors given here but kept separate.

The 3,216 beekeepers from New Zealand, managing 297,345 colonies before winter reported 21,124 (7.1%; 95% CI 6.8%-7.4%) colonies as dead/empty after winter, 9,408 (3.2%; 95% CI 3.0%-3.3%) colonies lost due to unresolvable queen problems and 545 (0.18%; 95% CI 0.15%-0.23%) colonies lost due to natural disaster, giving an overall loss rate of 10.5% (95% CI 10.1%-10.8%).

For the 30,491 beekeepers in all other countries combined, managing 837,081 colonies, 92,910 (11.1%; 95% CI 10.9%-11.3%) colonies were reported dead/empty after winter, 37,308 (4.5%; 95% CI 4.4%-4.6%) colonies were reported as lost due to queen

Table 1. Winter 2019/20 survey results, showing number of respondents with valid loss data, corresponding number of colonies going into winter, honey bee colony mortality rate and rates of loss due to queen problems and natural disasters (each with 95% confidence intervals (CIs)).

Country	No. of respondents	No. of colonies going into winter	% Mortality Rate (95% CI)	% Rate of loss of colonies due to queen problems (95% CI)	% Rate of loss of colonies due to natural disasters (95% CI)	Overall winter loss rate (95% CI)	Estimated % of beekeepers represented
EU countries							
Austria	1539	30,724	8.3 (7.6-9.0)	4.3 (4.1-4.6)	0.6 (0.4-0.8)	13.2 (12.5-14.0)	5
Belgium	564	4607	12.4 (10.7-14.2)	4.5 (3.9-5.2)	0.6 (0.4-1.0)	17.5 (15.7-19.4)	7
Bulgaria[a,b]	49	6682	5.8 (3.7-8.8)	3.4 (1.2-9.6)	2.0 (0.4-9.3)	11.3 (6.9-17.8)	<1
Czech Republic	1729	26,893	17.4 (16.3-18.6)	2.7 (2.4-3.0)	0.6 (0.5-0.8)	20.8 (19.6-22.0)	3
Denmark	1087	11,419	17.2 (15.7-18.7)	4.5 (4.0-5.1)	0.6 (0.4-0.8)	22.3 (20.8-23.8)	17
England[c]	1262	6379	9.0 (8.1-10.0)	6.5 (5.9-7.2)	1.2 (0.9-1.7)	16.8 (15.6-18.0)	4
Estonia	177	6740	6.1 (4.7-8.0)	5.3 (3.7-7.4)	1.5 (1.0-2.3)	12.9 (10.6-15.6)	3
Finland	215	8995	8.6 (7.1-10.3)	4.7 (4.1-5.4)	2.5 (1.6-3.9)	15.8 (14.0-17.7)	7
France[a]	1029	39,507	8.8 (8.0-9.6)	4.4 (4.1-4.7)	0.5 (0.3-0.7)	13.7 (12.8-14.5)	2
Germany	10,586	123,368	14.9 (14.5-15.2)	3.0 (2.9-3.1)	0.6 (0.5-0.6)	18.4 (18.0-18.8)	8
Greece	166	19,471	7.1 (5.6-9.0)	5.6 (4.7-6.7)	1.3 (0.7-2.6)	14.1 (11.9-16.5)	2
Ireland	375	3506	10.3 (8.8-12.0)	7.1 (6.2-8.1)	0.7 (0.4-1.0)	18.0 (16.3-19.9)	9
Italy[a]	352	7869	10.7 (9.3-12.3)	6.8 (5.6-8.2)	0.9 (0.6-1.5)	18.4 (16.4-20.6)	<1
Latvia	364	12,210	9.2 (7.8-10.8)	4.1 (3.4-5.0)	1.0 (0.7-1.3)	14.3 (12.7-16.0)	8
Malta	24	764	7.2 (3.9-12.8)	3.5 (2.0-6.1)	0.3 (0.0-92.4)	11.0 (6.9-17.0)	8
Netherlands	1857	14,169	8.6 (7.9-9.4)	6.5 (5.8-7.2)	0.6 (0.5-0.8)	15.6 (14.7-16.6)	17
Northern Ireland[c]	117	593	8.6 (6.4-11.4)	9.8 (7.7-12.3)	0.8 (0.3-2.8)	19.2 (16.0-22.9)	8
Poland	426	16,281	9.6 (8.0-11.3)	3.9 (3.3-4.6)	0.4 (0.2-1.1)	13.9 (12.2-15.8)	<1
Portugal[a]	125	11,691	11.7 (9.8-13.9)	6.5 (5.5-7.7)	4.3 (3.3-5.5)	22.5 (19.9-25.3)	1
Romania[a]	121	8298	9.1 (6.6-12.2)	5.8 (4.3-7.7)	0.2 (0.1-0.5)	15.0 (11.9-18.8)	<1
Scotland[c]	289	1384	10.8 (8.9-13.1)	7.9 (6.5-9.5)	0.9 (0.4-1.9)	19.6 (17.1-22.4)	13
Slovakia	539	9775	15.2 (13.1-17.6)	3.2 (2.6-3.9)	0.5 (0.3-0.9)	18.9 (16.7-21.4)	3
Slovenia	105	3107	7.2 (5.3-9.7)	21.7 (15.3-29.8)	0 NA	28.9 (22.3-36.6)	1
Spain[a]	152	19,589	25.3 (22.3-28.6)	9.7 (7.8-12.0)	1.5 (0.9-2.4)	36.5 (33.2-40.0)	<1
Sweden	1646	14,421	8.0 (7.3-8.8)	3.4 (3.0-3.9)	1.7 (1.4-2.1)	13.1 (12.3-14.1)	10
Wales[c]	90	523	10.3 (7.3-14.4)	6.9 (5.0-9.4)	4.2 (2.4-7.3)	21.4 (17.3-26.2)	5
Over all EU countries[c]	24,985	408,965	12.3 (12.1-12.6)	4.5 (4.4-4.6)	0.89 (0.83-0.94)	17.7 (17.5-18.0)	4
			European (Non-EU) countries				
North Macedonia	208	11,422	6.8 (5.8-7.9)	5.9 (5.0-6.9)	2.0 (1.3-3.0)	14.7 (12.9-16.7)	NA
Norway	765	11,990	2.9 (2.4-3.5)	3.8 (3.4-4.2)	0.7 (0.4-1.0)	7.4 (6.7-8.1)	17
Serbia	125	10,932	9.8 (7.0-13.5)	2.3 (1.9-2.9)	0.9 (0.4-1.7)	13.0 (10.1-16.6)	1
Switzerland	1665	21,934	7.1 (6.4-7.8)	5.7 (5.3-6.1)	0.4 (0.3-0.6)	13.2 (12.4-14.0)	10
Ukraine	702	42,518	5.4 (4.7-6.2)	2.2 (2.0-2.5)	1.7 (1.4-2.0)	9.3 (8.4-10.3)	<1
Over all European countries	28,450	507,761	11.1 (10.9-11.3)	4.3 (4.2-4.4)	0.95 (0.90-1.0)	16.4 (16.2-16.6)	NA
			Non-European countries				
Algeria[a]	197	16,412	5.5 (4.3-6.8)	4.0 (3.4-4.7)	2.8 (2.0-3.8)	12.2 (10.7-13.9)	<1
Egypt[a]	106	37,609	10.6 (9.1-12.2)	10.7 (9.1-12.4)	3.1 (2.4-3.9)	24.3 (21.6-27.1)	<1
Iran	1571	233,166	12.5 (11.5-13.4)	3.2 (2.8-3.6)	5.9 (5.3-6.6)	21.5 (20.5-22.6)	2
Israel[b]	43	25,279	2.3 (1.4-3.7)	5.2 (4.4-6.1)	1.3 (0.9-2.0)	8.8 (7.3-10.6)	9
Mexico[a]	124	16,854	11.4 (9.8-13.3)	11.5 (9.8-13.4)	5.5 (4.2-7.2)	28.4 (25.5-31.6)	<1
New Zealand	3216	297,345	7.1 (6.8-7.4)	3.2 (3.0-3.3)	0.2 (0.1-0.2)	10.5 (10.1-10.8)	34
Over all participating countries excl. New Zealand	30,491	837,081	11.1 (10.9-11.3)	4.5 (4.4-4.6)	2.6 (2.5-2.7)	18.1 (17.9-18.3)	NA
Over all participating countries	33,707	1,134,426	NA	NA	NA	NA	NA

The mortality rate and loss rates respectively were calculated as a percentage of colonies wintered which died or were lost due to unresolvable queen problems or to natural disaster. Percentage of beekeepers represented was expressed as the percentage of usable responses per estimated number of beekeepers in each country. Calculation of CIs used the quasi-binomial generalised linear modelling (GLM) approach in van der Zee et al. (2013).

[a]Limited geographical coverage of respondents providing data (see Figure 1); in some cases there is wider geographical coverage but the responses are mostly from a limited number of regions within the country;

[b]Mostly professional beekeepers;

[c]The UK left the EU at the end of January 2020, well through winter 2019/2020. For the purposes of the results here, the UK is included in the EU.

problems and 21,459 (2.6%; 95% CI 2.5%-2.7%) colonies were reported lost due to natural disaster, with an overall loss rate from all causes of 18.1% (95% CI 17.9%-18.3%). These rates of loss are similar to those from the 2019 survey (10.7%, 4.1% and 1.9% respectively), though the overall loss rate of 18.1% in the current study is a little higher than the 16.7% loss rate from winter 2018/2019 (Gray et al., 2020), a statistically significant difference. The corresponding figures from winter 2017/2018 are 10.0%, 4.8% and

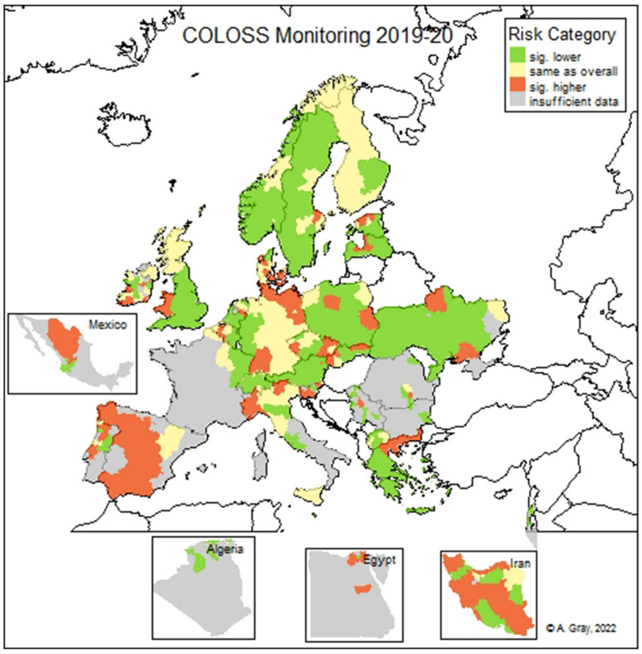

Figure 1. Map with traffic-light colour coding showing relative risk of overwinter colony loss at regional level for participating countries.
Notes: Regions with a relative risk of loss (loss rate divided by the loss rate over all regions excluding New Zealand) that is significantly higher/lower than 1 are shown in red/green respectively. Regions with a relative risk not significantly different from 1 are shown in yellow. Where no data were available or data were available from fewer than 6 beekeepers in a region within a participating country, this was treated as insufficient for reliable calculation and the region is shown in grey. Countries not present in the study are indicated in white (blank areas in the map). Island groups/regions are also coloured as one region provided at least 6 responses were available.

1.5% respectively, and an overall loss rate of 16.4% (Gray et al., 2019). Again, the loss rates for winter 2019/2020 are a little higher.

Comparing results for the countries in the Northern Hemisphere and for New Zealand, the loss rates are clearly higher in the former and in particular, there were more losses arising from natural disasters. The definition of what is a natural disaster is open to interpretation, however, and sources of such threats to honey bees do vary between countries. A proper comparison of the Northern and Southern Hemispheres would require the participation of more countries from the South.

For the European countries only, and also the countries belonging to the European Union ("EU countries", including the UK, which was a member state over most of winter 2019/2020), respectively, the results were: 28,450 and 24,985 beekeepers had valid loss data, wintering 507,761 and 408,965 colonies; the rates of reported loss from dead/empty colonies were 11.1% and 12.3%; the rates of loss due to queen problems were 4.3% and 4.5%; and the rates of reported loss from natural disasters were 0.95% and 0.89%, giving overall loss rates of 16.4% for the European countries and 17.7% for the EU countries. The losses due to queen problems were a little higher than in the previous winter (3.8% in each case) as was the overall rate of loss (which was previously 14.5% in each case). Compared to all countries except New Zealand, these European and EU results are similar but the loss rate from natural disasters is higher in the larger dataset, indicating that these losses are more common in countries outside of Europe.

As usual in these COLOSS studies, the overall loss rates for winter 2019/20 are seen to vary considerably between countries (Table 1, Figure 1). Spain had by far the highest loss rate, of 36.5%, with the next highest at 28.9% for Slovenia, then Mexico at 28.4%. The other 34 countries had loss rates below 25%. Egypt, which re-joined monitoring, had the next highest loss rate, at 24.3%. Portugal's loss rate was fifth highest at 22.5%, and like Spain and Slovenia, Portugal has been observed previously to have high winter losses (Gray et al., 2020). The lowest loss rates in this year, below 10%, were for Norway (7.4%), Israel (8.8%) and Ukraine (9.3%). New Zealand's loss rate of 10.5% was the next lowest. In the previous two surveys, Bulgaria had the lowest loss rate, and in this case, it was also relatively low at 11.3%. Romania, a new country to monitoring, had a loss rate of 15.0%, ranked in the middle. Relative positions and loss rates can change quite markedly from year to year; for example, Wales had a high loss rate of 21.4% this time compared to 9.8% the previous year, and Finland's loss rate was 15.8% compared to 6.3% the previous year, whereas others are fairly consistent. This is not surprising as climatic fluctuation may play an important role in the winter survival of honey bee colonies (Becsi et al., 2021). The acceptability of the higher rates of colony loss merits investigation, as do the economic costs of colony losses, including loss of (income from) anticipated hive products and the costs of replacing lost colonies.

Rates of loss from natural disasters ranged from none in Slovenia to more than 5% in Iran (5.9%) and Mexico (5.5%), while Portugal was next at 4.3%. The range of rates is similar to the previous year (0%-5.7%). Portugal had the highest rate both that year (winter 2018/2019) and the year previously, and Iran was the second highest in winter 2018/2019. A consistent pattern may be emerging for these countries. As we have previously found (Gray et al., 2020), almost all of these rates are less than about 3% and many below 1%. For most countries, loss due to natural disaster is a small contributor to the overall loss rate.

Mortality rates, i.e., rates of losses from dead or empty colonies, varied from less than 5% for Israel (2.3%) and Norway (2.9%) to 25.3% for Spain, followed by the Czech Republic at 17.4%, Denmark at 17.2% and Slovakia at 15.2%, while all others were above 5% and below 15%. New Zealand's loss rate from dead colonies was relatively low at 7.1%. These loss rates are more variable between countries than the loss rates from natural disaster or queen problems. To some extent, they do depend on the nature of beekeeping in the country providing the results reported here. For example, Israel also had the lowest mortality rate for winter 2018/2019 (2.1%) and the beekeeper respondents are largely professional. Colony failures due to pests and pathogens also fall in this category. The epidemiology of those may explain some of the variations among countries.

The final type of loss considered here is losses due to irresolvable queen problems. These rates of loss also varied considerably. The lowest such loss rates were 2.2% in Ukraine, 2.3% in Serbia and 2.7% in the Czech Republic, compared to more than 10% in Slovenia (a very high 21.7%), Mexico (11.5%) and Egypt (10.7%). Slovenia also had the highest loss rate from queen problems for winter 2018/2019 (18.1%). The reasons for such high queen problem losses require investigation, to find out if there are biological causes or bias in the translation of the survey. In the present study, this type of loss accounts for most of the losses in Slovenia, unlike Spain for which most of its very high overall loss rate derives from colonies that died.

The size of the collected dataset, representing many thousands of beekeepers, allows very sensitive statistical testing of the overall effects of various factors that may be associated with the risk of winter loss. Any statistical test has associated risks of error, i.e., failing to detect a genuine effect or wrongly leading to a statistically significant result that is actually spurious. By repeating the same tests on datasets collected in different years, for each year separately, effects found to be significant can become more convincing as evidence builds up. In this series of short papers on winter losses we have so far tested several potential risk factors: beekeeping operation size and migration of colonies (Brodschneider et al., 2016, 2018), effects of various forage sources (Gray et al., 2019), and most recently the effect of the proportion of colonies going into winter with young queens (Gray et al., 2020). The effects of forage sources were found to vary depending on the country and were best examined at the country level. However repeating tests of the other factors on the whole dataset, i.e., for all countries combined, is worthwhile. This is done for each factor individually by fitting univariate quasi-binomial generalised linear models (GLMs) as recommended in van der Zee et al. (2013) as a suitable approach for colony loss data, owing to the degree of variation in the data being greater than is consistent with a binomial model.

As in the previous year, in this model fitting, we excluded losses from natural disasters, which are largely beyond the control of the beekeeper, so as to examine the effect of each factor of interest on the risk of loss experienced as a dead or empty colony or one lost because of an unresolvable queen problem after winter. We also excluded New Zealand from the model fitting because of the difference in the timing of winter there as well as the lack of data on some of the factors investigated.

As previously, we categorise operation size as up to 50 colonies, 51-150 colonies and over 150 colonies. By far, the majority of beekeepers in this survey are in the first of these categories; 90.2%, 6.6% and 3.2% of the 30,491 beekeepers were in each of the three categories, managing 296,763 colonies, 177,501 colonies and 362,817 colonies respectively. Operation size was a highly significant effect ($p < 0.001$), indicating a significantly lower loss rate for beekeeping operations with over 50 colonies. The loss rates in each group were 16.6%, 14.6% and 15.2% for the smallest to largest-size operations. These results are broadly consistent with the findings of our previous surveys, and it is clear overall that smaller operations have higher losses, a finding which is likely to be due to different management practices in the different groups.

Most beekeepers in the survey (81.7% of beekeepers with usable data) did not migrate their colonies. Migration was also highly significant ($p < 0.001$), with loss rates of 15.2% and 16.1% for the groups replying "Yes" and "No", respectively, to whether they had migrated their colonies the previous season (and 11.6% for the small group of 163 beekeepers responding "Don't know"). All differences between groups were significant, with the result that the "Yes" group had lower losses than the "No" group. This is the opposite way round from the finding of the 2019 survey (Gray et al., 2020), but consistent with the results of the 2018 survey (Gray et al., 2019). While we have found that migration is always significantly associated with winter loss, the direction of the effect does vary from year to year. This may possibly reflect a different balance from year to year of two factors working in opposite directions, namely that on the one hand migrated colonies are potentially more exposed to disease, toxins, etc., while on the other hand beekeepers who migrate their colonies are, in some countries at least, much more likely to be more experienced beekeepers than those who do not.

In Gray et al. (2020), we considered the effect of a young queen on the risk of winter loss. This also proved to be a highly significant effect, indicating that a larger proportion of young queens in a beekeeping operation was associated with a lower risk of colony loss. This was an important finding, with practical implications for beekeepers in terms of re-queening as a way to improve colony survival. The proportion of young queens is calculated, for beekeepers supplying consistent data, from the total number of colonies going into winter and, where this is known and stated, the number of these with a new queen. Of the 30,491 beekeepers with consistent loss data, 27,348 of them also had valid data in the present spring 2020 survey for this calculation of the percentage of young queens. While the results are not shown in detail here, the similarity of the results obtained from this year compared to the previous year relating the proportion of new queens to the risk of colony winter loss is striking and again the effect is highly significant ($p < 0.001$). Once more, the conclusion from this very large sample of beekeepers from many countries is that a greater level of queen replacement is associated with less colony loss. This applies to losses from queen problems, dead/empty colonies, and the total of these two types of colony loss.

All three factors, operation size, migration and proportion of young queens, were also included in a multivariable main effects quasi-binomial GLM, and all three remained highly significant ($p < 0.001$), meaning that when each factor is taken into account the other factors are still strongly associated with colony winter losses.

Colony loss rates vary between countries participating in the monitoring survey in any one year and between years, for many reasons. These include environmental conditions, such as weather patterns or pathogen pressure, as well as colony management practices. Therefore, the representativeness of each set of survey respondents for the beekeeper population in their country is important and is an aspect of the monitoring survey which we seek to improve on an ongoing basis. National coverage and the proportion of beekeepers answering the survey questionnaire (last column of Table 1) are in turn both aspects of how representative the respondents are.

In summary, despite the challenges of Covid-19 in 2020, the survey response rates in most countries were encouraging. In a few countries, conditions for carrying out surveys are challenging and it is not always possible to participate every year or in some instances to achieve more than a small sample of responses. This is partly dependent on the survey mode, and the online survey approach has proved to be more robust than in countries where data collection is reliant on questionnaire data being collected at beekeeper meetings. It is encouraging that in a few other countries like Spain, France, or Italy, where responses have been more regional than national, a greater level of national coverage is being achieved and efforts are continuing to increase coverage. We aim to continue growing the network of participating countries, including greater representation of countries outside of Europe, as well as keeping involved the long-standing participants in colony loss monitoring. Broadening the network of countries in the COLOSS monitoring survey more globally brings its own challenges, such as addressing the needs of countries with a warm climate and lack of a distinct winter.

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