

Green Open Access version of the Accepted Manuscript:

How best to share research with study participants? A randomised crossover trial comparing a comic, lay summary, and scientific abstract

Published in the Journal of Visual Communication in Medicine:

Kearns C, Eathorne A, Kearns N, Anderson A, Hatter L, Semprini A, and Beasley R. How best to share research with study participants? A randomised crossover trial comparing a comic, lay summary, and scientific abstract. *Journal of Visual Communication in Medicine*. Published online April 5, 2022:1-10. doi:[10.1080/17453054.2022.2056321](https://doi.org/10.1080/17453054.2022.2056321)

Abstract

Healthcare research is traditionally published in academic papers, coded in scientific language, and locked behind paywalls – an inaccessible form for many. Sharing research results with participants and the public in an appropriate, accessible manner, is an ethical practice directed in research guidance. Evidence-based recommendations for the medium used are scant, but science communication advice advocates principles which may be fulfilled well by the medium of comics. We report a randomised crossover study conducted online, comparing participant preferences for research results shared in the medium of a comic, a traditional lay text summary, and the control approach of a scientific abstract. 1236 respondents read all three summaries and ranked their most and least preferred formats. For the most preferred summary, the comic was chosen by 716 (57.9%), lay summary by 321 (26.0%), and scientific abstract by 199 (16.1%) respondents. For the least preferred summary the scientific abstract was chosen by 614 (49.7%), lay summary by 380 (30.7%) and comic by 242 (19.6%). Review of free-text responses identified key reasons for the majority preferring the comic over the others, which included finding this easier to read and understand, more enjoyable to consume, and more satisfactory as a medium of communication.

Background

Healthcare research is typically published in academic papers, encoded in scientific language, and locked behind paywalls, where it is inaccessible to many audiences. Sharing study results with participants and the public in an appropriate, accessible way, is an ethical practice directed in guidance from national research bodies in Aotearoa (New Zealand, NZ),¹ and Australia.² In the United Kingdom, increasing the accessibility of health research to the public, including the dissemination of results, has been set as a priority by the National Institute for Health Research.³ There is a limited evidence base informing the choice of medium in which to disseminate results with participants and the public, but traditionally this takes the form of a lay text summary.

Research investigating patient and trial participant understanding of information materials designed for them indicates that there is often limited comprehension.⁴⁻⁶ Science

communication guidance advocates for using simplified language, pictures, and telling stories to break down unfamiliar concepts and terminology that characterise published scientific literature.^{5,7-10} The medium of comics can fulfil these principles, and has been effectively used to engage patients and the general public with medical science, such as disseminating evolving scientific understanding of COVID-19, and explaining public health measures during the pandemic.^{11,12} Comics are embraced as a communication tool by international organizations like the WHO, through support for the design of original comics with public health goals,¹³ and dissemination of COVID-19 comics that share expert advice.¹⁴ In NZ, comics have become a familiar form for sharing science with the public in mainstream news through the popular collaborations of artist Toby Morris and scientist Professor Siouxsie Wiles,¹⁵ and have been used to share study results with the public.¹⁶

We have published evidence demonstrating that comics can engage public audiences with healthcare research and findings.¹⁷⁻¹⁹ However, the use of this medium for sharing the results of healthcare studies with research participants, has not to our knowledge, been previously investigated in a comparative study. We assessed study participant preferences for the medium they received study results by comparing a novel comic summary, the traditional approach of a lay summary, and a published scientific abstract. Our hypothesis was that the comic would be preferable to a lay summary, which in turn would be more preferred than a scientific abstract.

Materials and methods

Three research summaries were created to convey share the findings of a national-scale study of household units during the first country-wide lockdown for COVID-19 in NZ.²⁰ The 'scientific' summary was the published abstract of this study. The 'lay summary' was a more accessibly-written version which avoided or explained technical terminology, and had a less formal tone. This was written in collaboration with authors of the original research and adjusted with feedback from medical and non-medical members of the team who were familiar with writing about science for both public and professional audiences. The comic shared a text narrative with the lay summary, had art designed by a doctor who was also a medical illustrator experienced in public engagement using comics, and was also developed iteratively with wider team feedback (Figures 1-3). The summaries are available as Supplementary Materials.



Figure 1. An excerpt from the comic summary. Reprinted with permission.



Figure 2. An excerpt from the comic summary. Reprinted with permission.

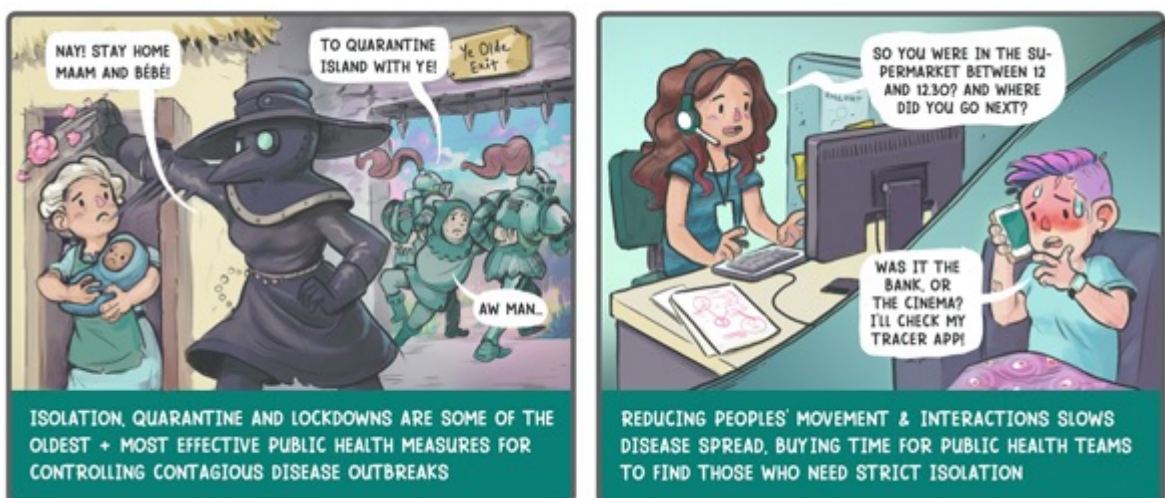


Figure 3. An excerpt from the comic summary. Reprinted with permission.

An online survey was designed using REDCap electronic data capture tools hosted at the Medical Research Institute of New Zealand.^{21,22} This presented the three research summaries in a random order with no fixed washout period to facilitate later ranking and mitigate survey fatigue. After viewing each format, respondents rated three domains; enjoyment, understanding, and satisfaction, using visual analogue scales (VAS) that ranged from 0-100. After viewing all three, respondents could indicate their most and least preferred formats and optionally explain this choice with free-text feedback.

A survey invitation list was formed from 3967 participants of the previous study who had given permission to be contacted about the study results or participation in further research.²⁰ The eligibility criteria under which the previous study recruited were being resident in NZ and aged 16 years or older. A statistician masked to allocation randomised this list with equal chance to one of six orders of presenting the three summary formats (Figure 4). This was intended to mitigate effects of survey fatigue and order bias. Survey invitations were emailed and non-responders were sent a second invitation two weeks later. The survey was made available for four weeks in total.

Continuous data was summarised by mean and standard deviation, median and inter-quartile range and minimum to maximum. Categorical variables were summarised by counts and proportions expressed as a percentage. Ordinal variables were described by continuous methods as well as by counts in each category. Comparisons of VAS scores were made by a linear mixed model and comparison of length was by generalised linear mixed model, with fixed effects of summary type and summary order, and random effect for participant to account for the cross-over design. Comparisons of proportions were by chi-squared tests. Free-text feedback was reviewed, coded, and summated without formal qualitative analysis.

Ethics

This research was outside the scope of NZ Health and Disability Ethics Committee (HDEC) review under the minimal risk observational study exemption.

Results

There were 1236 complete responses to 3967 invitations (response rate 31.2%, Figure 4). Table 1 shows the demographic characteristics compared with the original study, and national NZ data from the 2018 Census.²³ A majority of respondents (68.9%) indicated they were 'confident reading medical language e.g. research papers, textbooks, and other resources aimed at healthcare professionals'.

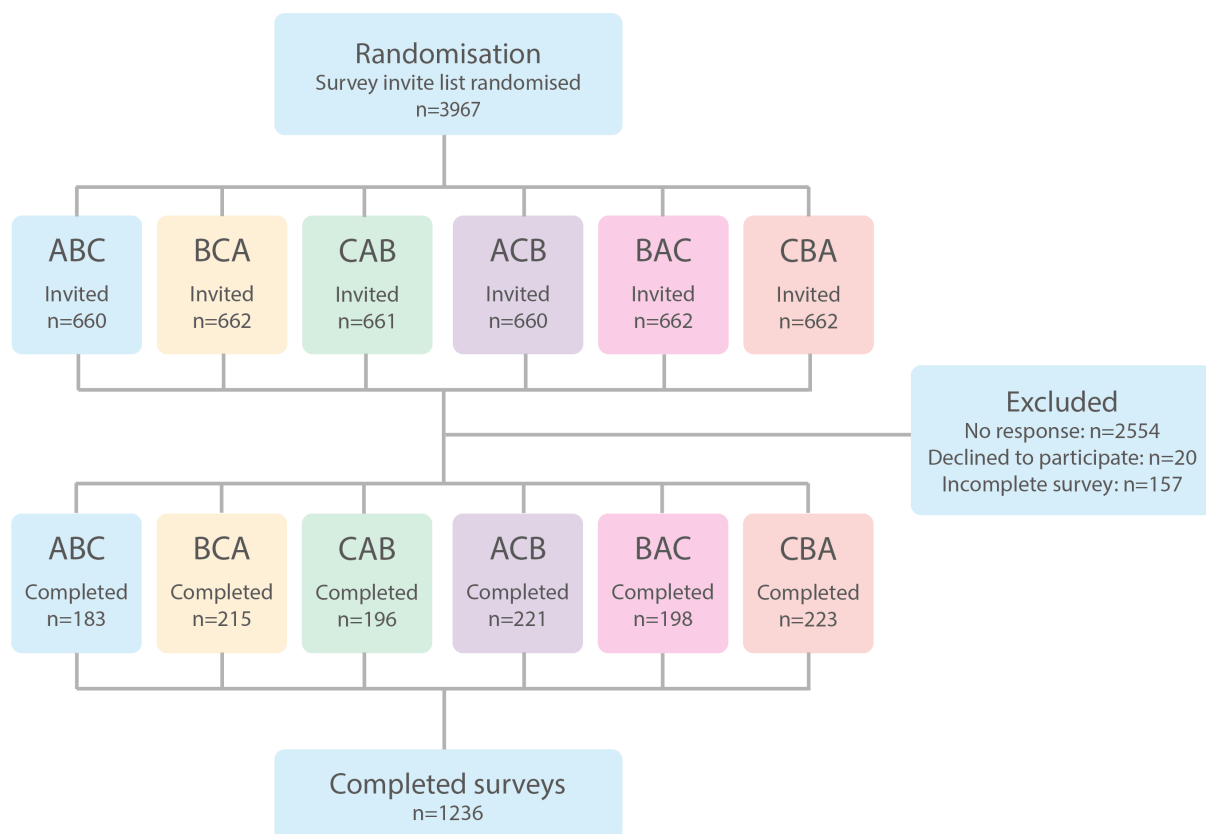


Figure 4. Participant flow diagram

| Variable | N/1236 (%) | Original study ²⁰ | National %* |
|--|-------------|------------------------------|----------------------|
| Age | | | |
| N/14,687 (%) | | | |
| 17-24 yrs | 49 (3.96) | 901 (6.1) | (13.2 [∇]) |
| 25-44 yrs | 383 (31.0) | 6,285 (42.8) | (26.6) |
| 45-64 yrs | 532 (43.0) | 5,748 (39.2) | (25.4) |
| 65+ yrs | 267 (21.6) | 1,744 (11.9) | (15.2) |
| Gender^ψ | | | |
| N/14,361 (%) | | | |
| Female | 979 (79.2) | 12,111 (84.3) | ψ |
| Male | 245 (19.8) | 2169 (15.1) | ψ |
| Another gender | 8 (0.6) | 81 (0.6) | ψ |
| Prefer not to say | 4 (0.3) | 0 (0) | ψ |
| Ethnicity[†] | | | |
| N/14,344 (%) | | | |
| European | 1108 (89.6) | 12,589 (87.8) | (70.2) |
| Māori | 64 (5.2) | 978 (6.8) | (16.5) |
| Pasifika | 10 (0.8) | 137 (1.0) | (8.1) |
| Asian | 34 (2.8) | 549 (3.8) | (15.1) |
| Middle Eastern/Latin American/African | 7 (0.6) | 86 (0.6) | (1.5) |
| Other | 8 (0.6) | 5 (0.03) | (1.2) |
| Not specified | 5 (0.4) | - | - |

* National percentages are for Census, usually resident population counts as of 30/6/18

[∇] Includes 15-16 year olds as 2018 Census data could not be separated to match study age group

^ψ Gender has not been collected in a national Census to date

[†] Prioritised ethnicity using Level 1 codes

Table 1. Respondent demographics compared to the original study, and 2018 New Zealand Census.

Most and least preferred research summary formats

The most preferred summaries were the comic N= 716 (57.9%), lay summary N= 321 (26.0%), and scientific abstract N= 199 (16.1%). The least preferred summaries were the scientific abstract N= 614 (49.7%), lay summary N= 380 (30.7%) and comic N= 242 (19.6%). Figure 5 summarises the proportions of participants who most (5A) and least (5B) preferred each format. The trend of a majority most preferring the comic, and a majority least preferring the scientific abstract, was observed in all groupings except 18-24 year olds, where although the comic was still most preferred, the preferences for scientific abstract and lay summary were reversed. There was strong evidence that age group and familiarity with scientific language were associated with both least and most preferred summary.

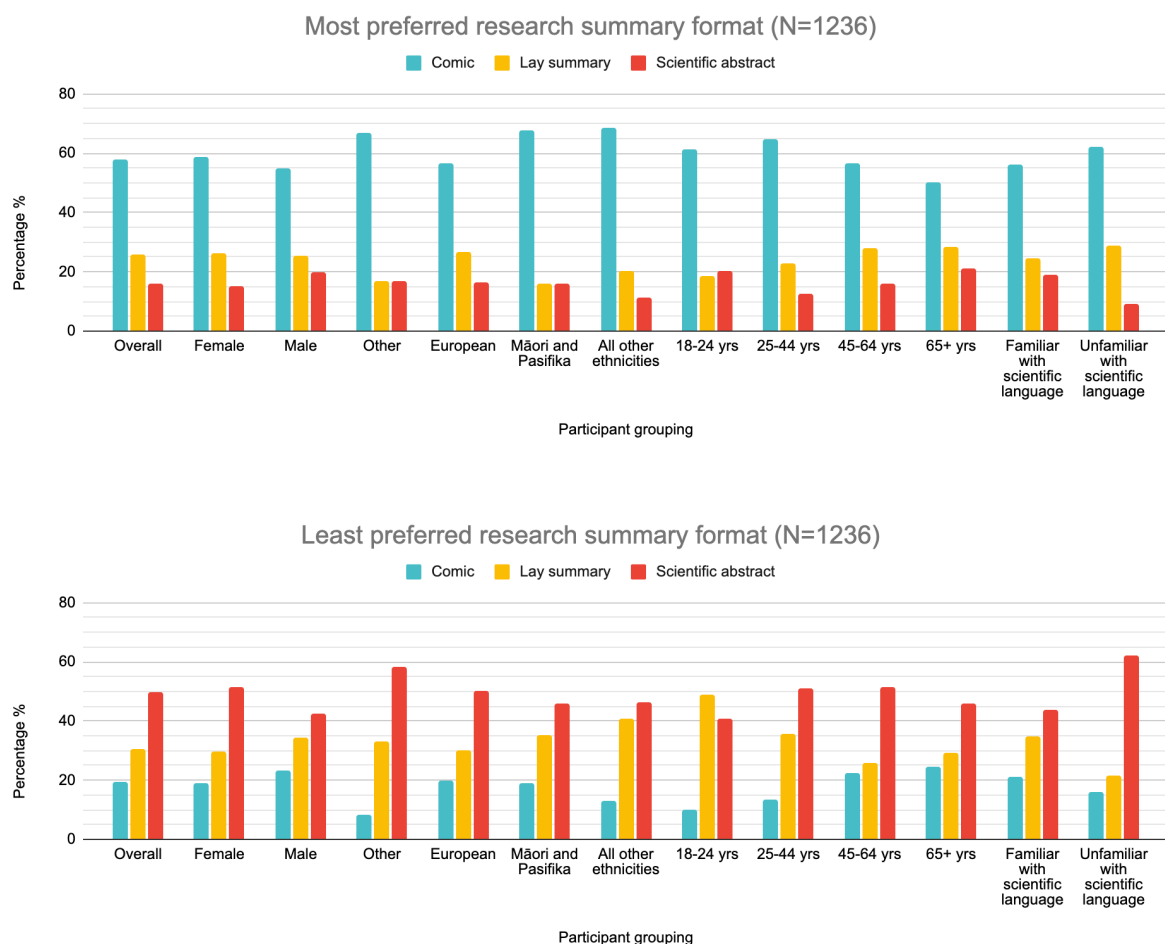


Figure 5. Proportions of participants who (A) most and (B) least preferred each summary format, overall and according to various sub-groupings. Age and ethnicity data were grouped to power comparisons.

Free-text responses

Free-text comments discussing the choice of most preferred format were available from 582

(comic), 252 (lay summary), and 159 (scientific abstract) respondents. Comments discussing the choice of least preferred format were available from 71 (comic), 252 (lay summary), and 453 (scientific abstract) respondents.

Feedback on the comic

The comic was reported to be easier to read and understand, more interesting, engaging, enjoyable, better at communicating data, to be relatable, provide more useful information through context, and to be more memorable. Many felt it was a faster format to read, despite being the longest in terms of both scrolling required, and text content. Many commented specifically on enjoyment of the art style and use of humour, and felt that the comic medium was non-threatening compared to the other media. Some mentioned this format was a trustworthy and familiar form of communication similar to the comic collaborations between microbiologist Professor Siouxsie Wiles and artist Toby Morris^{11,15} that gained popularity in NZ during the pandemic.

For the minority of respondents who least preferred the comic, reasons included finding the visuals distracting, the format too long or too short, that it had not enough or too much detail, could undermine the seriousness of the topic with the style or use of humour, and could be patronising or childish for some people. Despite being their least preferred medium, some respondents commended the comic for being entertaining, accessible for public audiences, or liked the idea but not the execution or the layout on a mobile device.

Feedback on the lay summary

For those who most preferred the lay summary, themes elicited from responses included being easy to read on a mobile device, easy to understand, concise, pitched at the right level with a casual tone, and their dislike of the comic's humour. For those who least preferred the lay summary, themes included being too long or short, boring, too serious or not serious enough, hard to read, understand, and remember, and some finding the language patronising or childish.

Feedback on the scientific abstract

For those who most preferred the scientific abstract, this was felt to be good for a professional medical or academic audience, less open to misinterpretation, concise and to the point, a more credible format, more informative, and simpler. Some respondents noted value in the comic to help communicate data with visuals, to share the science with public audiences, and suggested a summary with elements of both the comic and scientific abstract would be ideal. For those who least preferred the scientific abstract, the overwhelming majority cited that it was boring, hard to read, too scientific, not relatable and did not have enough context making it difficult to appreciate the point or impact of the research. One specifically mentioned that it would discourage people from future research participation.

Understanding, satisfaction, and enjoyment

VAS scores for understanding, satisfaction, and enjoyment of each format are summated in Figure 6. There was strong evidence the comic and lay summary had higher VAS scores than the scientific abstract. There was strong evidence that the comic had a higher VAS score in

the 'enjoyment' domain compared to the lay summary. There was no evidence of difference in the understanding or satisfaction domains between comic and lay summary.

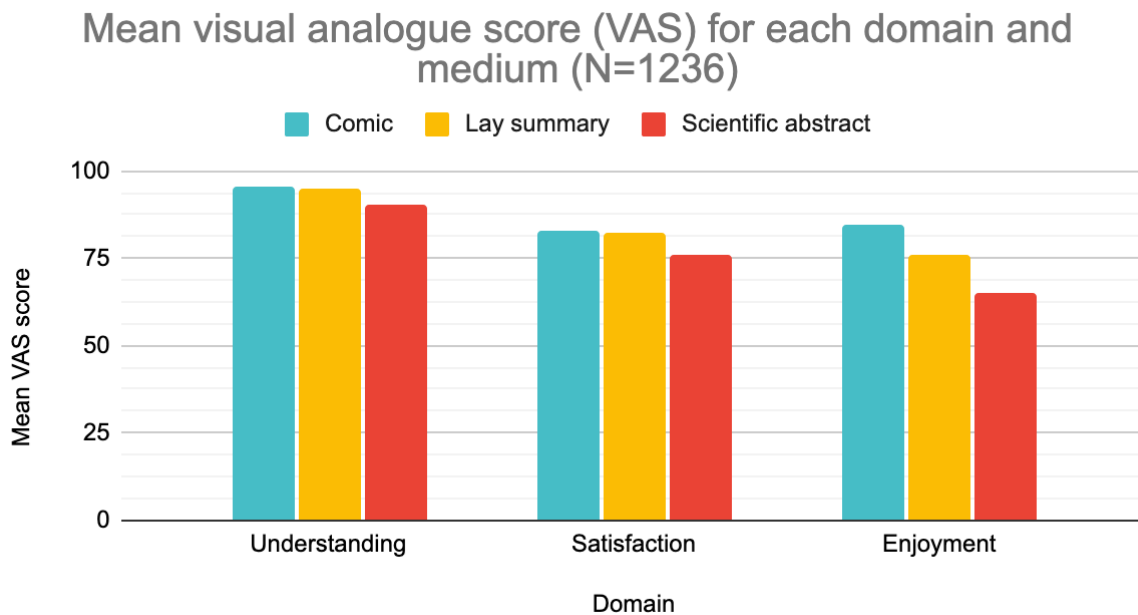


Figure 6. Mean visual analogue score (VAS) score out of 100 by research summary medium

Summary length

Respondents rated the length of each research summary (Figure 7). The majority of respondents felt this was 'about right' for each summary medium. Approximately twice as many respondents felt each summary medium was not long enough (range 13.8-19.9%), compared to too long (6.8-8.3%). Differences between comic and scientific abstract, and lay summary and scientific abstract, were significant at the level of $p < 0.001$ in a linear mixed model.

Rating of research summary length (N=1236)

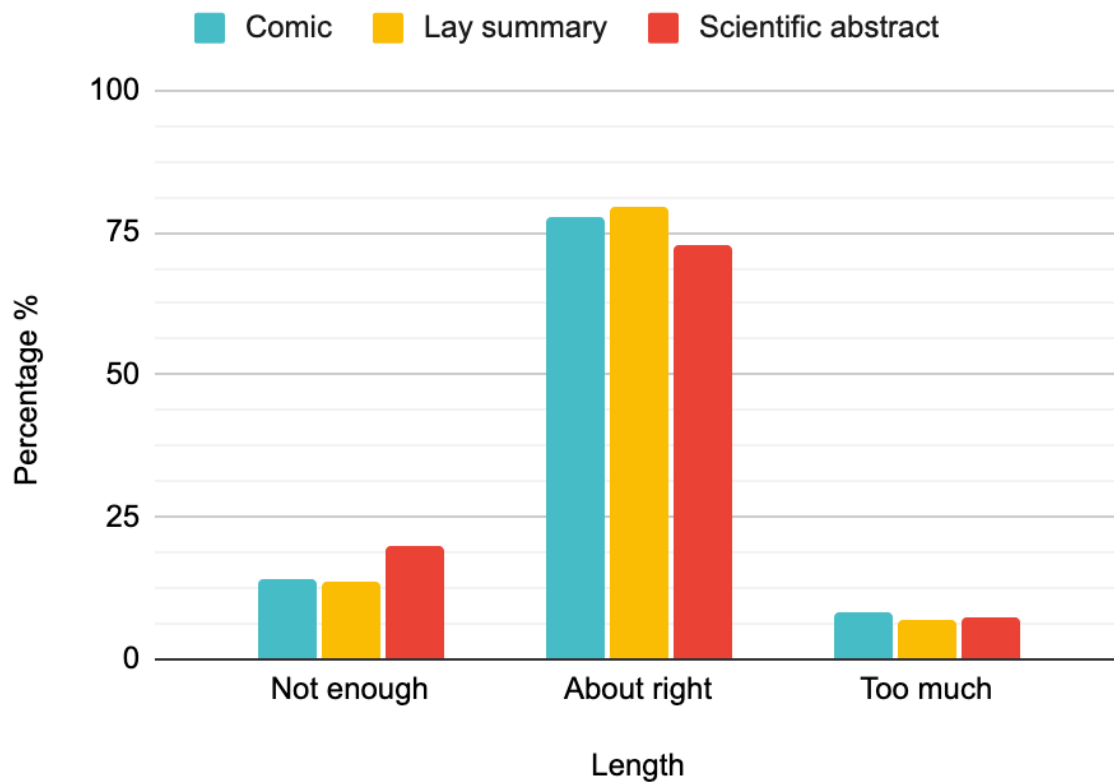


Figure 7. Respondent rating of summary length by research summary medium

Comic ratings

Respondents were additionally asked to rate their agreement with four statements hypothesised to be potential strengths of comics based on prior research.^{11,17,19,24} A majority agreed with all four statements (range 81.8-84.5%) regardless of the most and least preferred medium chosen.

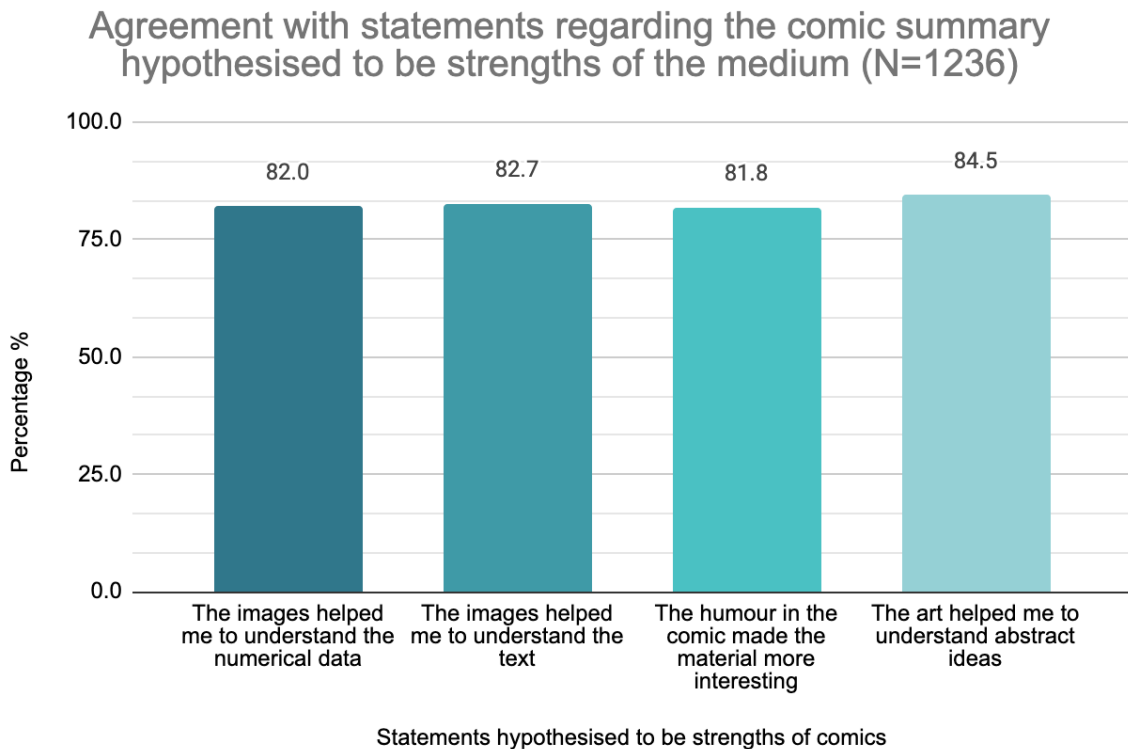


Figure 8. Respondent agreement with statements hypothesised to be strengths of comics as a medium based on previous research.

Alternate languages

77 participants (6.2%) indicated that they would have preferred the summaries to be available in another language. Some specifically requested that versions of any summary should be available in Māori and New Zealand Sign Language (NZSL), which are official languages in NZ, at a minimum. Others stated that versions would ideally be available in all languages used in NZ, regardless of prevalence.

Discussion

Key findings

The comic was the most preferred medium for reading study results by a majority of respondents in both the primary analysis and all sub analyses, evidencing our primary hypothesis. There was strong evidence of higher VAS scores with the comic across all three domains of satisfaction, understanding and enjoyment, when compared to the scientific abstract. The comic also had a higher VAS score for enjoyment when compared to the lay summary. Interestingly, regardless of most and least preferred medium, over 80% of all respondents indicated that the comic helped them understand numerical data, text, abstract ideas, and that the humour made the material more interesting (Figure 8).

Free-text feedback indicates that a combination of formats may have been appreciated by some respondents, where more limited comics for specific hard-to-communicate concepts or data could supplement a lay text or scientific summary. Despite the preference for and

effectiveness of comics, given the resources required for their creation (access to a suitable artist, time, cost); a more limited hybrid summary, or provision of both lay and scientific abstracts to participants, may be alternate approaches in resource-limited settings.

Participants of the original study were recruited from the general public. As the current study invited a subset of these; our results may add evidence supporting the use of comics to share research with wider public audiences in addition to that of study participants. In the sub-analyses of gender and ethnicity, when compared to the overall group, the proportion of respondents who most preferred the comic was greater for those identifying as 'other' for gender (+15.2%), and Māori/Pasifika (+16.8%) and 'other' (+18.3%) for ethnicity. This suggests additional value in the use of comics with these audiences, which echoes prior findings that comics may support engagement of audiences with a greater diversity of gender and ethnicity than standard methods.^{19,20} This sentiment was expressed by one respondent who most preferred the comic summary, *"I especially loved the diversity, humanity and humour shown in the cartoons. For example the range of ethnicities and ages, the random whale popping up and the child wanting to play with the grandparent."* Another reported that *"This [comic] format works for any of us, regardless of age, gender, cultural, learning preferences"*.

There are many situations in which evidence-based information must be communicated to patients and their families, such as when explaining a diagnosis or treatment to support informed decisions about care. In NZ, the Health and Disability Commissioner Act asserts that all health consumers have the right to effective communication "in a form, language, and manner that enables the consumer to understand the information provided".²⁵ Given the evidence presented regarding dissemination of healthcare research with study participants; comics may be also be a useful tool to share other kinds of information with patients and their families in aspects of healthcare practice.

Over two thirds of respondents indicated they were 'confident reading medical language' which may indicate selection bias toward a scientifically literate audience. The question may not have been clear given numerous agreeing respondents were younger than 18 years thus unlikely to have professional medical or research experience. It is possible that many respondents answered this way due to repeated exposure to the subject of COVID-19 through the pandemic at the point of participation. Although a greater proportion of those who were not confident reading medical language most preferred the comic, and least preferred the scientific summary, the same overall trend in most and least preferred formats was observed irrespective of this answer.

Free-Text responses

Formal qualitative analysis of free-text responses was beyond the scope of this study so we limit discussion to key themes regarding the comic, which was the more novel and most preferred approach. The format was felt to offer additional information by giving context through the artwork, helping readers relate to the research and consider how it applied to their own lives, *"I thought the images enriched the summary and elaborated on the information given e.g. examples of why people left the house, different essential workers, different resource types covered by "healthcare resources" etc"*. In addition to increasing the

clarity of communication, this also served to convey a human element of empathy that may have been missing in the other summaries *“text summaries...made it feel very 'distant', ie not about actual people, which is a key part of connecting with readers”*. This aspect helped some viewers connect with the material *“Depiction of people is more relatable than words alone”*. *By considering these human examples, “[the comic] communicates the science but also the sense of how we lived during lockdown, which may or may not have been similar to others' experience”*. This style of communicating around the serious topic of COVID-19 was welcomed *“...adds a human touch to it which is vital when everything is so clinical and boring around COVID”*.

Almost half of respondents who explained why they most preferred the comic reported that it was easier to read and understand, *“Having pictures definitely takes the work out of trying to visualise what the text actually means. It gives me the feeling that the results are relevant to me as it's presented in terms I can understand”*. Specific comments were also made regarding accessibility, *“This form of communication recognises different forms of literacy”*, and almost a third described how it was more engaging and interesting so reading was an enjoyable experience compared to the other formats, *“Really engaging and enjoyable to read with the illustrations”*, keeping them reading the full content *“The format carried the reader forward to the end; the volume of facts in the other two formats became numbing and overwhelming by the end of the summaries”*. Information that is available but not consumed will have limited impact. In addition to ensuring the quality and accuracy of any resource used in a healthcare related setting, consideration should be given to the accessibility (so it is easy to find and read) and presenting in an engaging way (so that it is read in full). The ease-of-sharing should also be considered to support dissemination, *“Seemed friendlier, data was presented in a way I could easily share with friends or family who are not science/maths minded”*).

Many respondents reported that they trusted comics as a credible medium to learn about research, citing familiarity with the collaborations between well-known science communicators in NZ.¹⁵ With over 80% of respondents being aged 25-64, and a majority favouring the comic summary, this evidences that the medium can serve as a credible means to share research with adult audiences. A number of respondents had not expected to prefer the comic, shown nicely by *“I'm surprised at my answer, but it really does help it sink in in a way that just words don't”*, and *“I was agreeably surprised by the Comic format. This was so skilfully created that it conveyed the information by using graphics to emphasise and visually convey the messages. Bravo!”*. A number of respondents commented on the utility of visuals for communicating statistical information; *“the graphics helped cement the stats and made the findings really clear”*, and that *“it really was easier to understand the statistics shared, when a visual aid is used”*.

The majority of respondents enjoyed the humour of the comic (Figure 8), and a large number described this specific enjoyment of the humour and art style in free-text comments, *“humour always great communication tool”* and *“humour injected into the images kept my attention and i didn't have to scan again as I read through the text”*. There was, however, a small number of respondents who felt this was child-like and potentially patronising *“I thought the illustrations were amazing. Loved them. But I felt that I was being talked down to - treated like an infant”*. Some felt this was suitable for specific audiences,

“Can understand why it would appeal to younger people. Felt it was aimed at say aged 12-25”. We note that the age category with the greatest proportion most preferring the comic summary was older than this suggestion (64.8% in the 25-44 years group, Figure 5A), and also that this was the medium most preferred by a majority of respondents for all age groups.

Writing and illustrating in an appealing way for specific audiences is key to engagement with resources, but a highly subjective endeavour, and changing language and culture may affect suitability over time. Both visuals and words can be interpreted subjectively, so the intended message could be made clearer, confused, or skewed by combined use. Lessons may be learned from study of popular media (what is engaging who and in what way?), and collaborations (how was a particular piece of media developed?). One such example has been the COVID-19 Chronicles from National University Singapore (NUS), a collaborative effort between science experts, artists, and the university communications team.¹² This series has been developed to rapidly share evolving science and changing public health policy in Singapore used to control the pandemic.^{26,27} Each comic presents one key message in an entertaining narrative backed up by a simple message from an expert in cartoon form. NUS have collected the series in a book which also shares insight into the creative process behind the series.²⁷

Strengths

The results of this randomised crossover study are powered by 1236 respondents who each reviewed and rated all three forms of research summary, allowing considered ranking of their most and least preferred formats. With approximately equal proportions of respondents viewing the summaries in each of six possible orders, any effect of non-response bias, survey fatigue or order bias, is likely to be non-differential. To our knowledge, there has not been prior research examining study participant preferences for receiving research summaries, a critical perspective when evaluating science communication methods.

Limitations

Based on demography, the respondents of this study are not a representative sample of NZ audiences which may limit extrapolation of results to this or other countries. Over 1 in 20 participants felt that results should be available in more languages than English; this is likely an underestimation given the underrepresentation of NZ's ethnic diversity. Our approach was chosen to power three summary comparisons in the same language, but study of more inclusive language options is worthy of specific investigation. Formal qualitative analysis of free-text responses was beyond the scope of this study but may provide further insight into respondent decisions. Variables such as the comic art and writing styles, subject matter, summary lengths, and subjective audience factors, mean that alternate approaches to each medium may produce different results. This study could be considered an exploration of a few points on the spectrum of ways that research can be shared with study participants. Findings should not be interpreted as a definitive answer to the medium that will suit all situations and audiences.

Conclusion

After examining all three formats of the research summary, a majority of respondents most preferred the medium of comics, and least preferred the scientific abstract. Key reasons for preferring the comic summary over the other formats included finding comics easier to read and understand, more enjoyable to consume, and more satisfactory as a medium to receive study results. Comics were an appropriate and engaging way to share pandemic research results with the majority of study participants.

References

1. Health Research Council of New Zealand. HRC Research Ethics Guidelines. Published online March 2021. Accessed January 7, 2022. https://gateway.hrc.govt.nz/funding/downloads/HRC_research_ethics_guidelines.pdf
2. National Health and Medical Research Council (Australia), Australian Research Council, Universities Australia. *National Statement on Ethical Conduct in Human Research 2007 (Updated 2018)*. National Health and Medical Research Council; 2018.
3. Denegri S, Coldham T, Eglin S, et al. Going the extra mile: Improving the nation's health and wellbeing through public involvement in research. Published online 2015. Accessed February 14, 2022. <https://www.nihr.ac.uk/documents/about-us/our-contribution-to-research/how-we-involve-patients-carers-and-the-public/Going-the-Extra-Mile.pdf>
4. Berger O, Grønberg BH, Sand K, Kaasa S, Loge JH. The length of consent documents in oncological trials is doubled in twenty years. *Annals of Oncology*. 2009;20(2):379-385. doi:10.1093/annonc/mdn623
5. Houts PS, Doak CC, Doak LG, Loscalzo MJ. The role of pictures in improving health communication: A review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*. 2006;61(2):173-190. doi:10.1016/j.pec.2005.05.004
6. Foe G, Larson EL. Reading Level and Comprehension of Research Consent Forms: An Integrative Review. *Journal of Empirical Research on Human Research Ethics*. 2016;11(1):31-46. doi:10.1177/1556264616637483
7. Centers for Disease Control and Prevention. Simply Put: A guide for creating easy-to-understand materials. Published online 2010. Accessed July 18, 2020. https://www.cdc.gov/HealthLiteracy/pdf/Simply_Put.pdf
8. Farinella M. The potential of comics in science communication. *JCOM*. 2018;17(01):Y01. doi:10.22323/2.17010401
9. McDermott JE, Partridge M, Bromberg Y. Ten simple rules for drawing scientific comics. Markel S, ed. *PLoS Comput Biol*. 2018;14(1):e1005845. doi:10.1371/journal.pcbi.1005845

10. Safer RS, Keenan J. Health literacy: the gap between physicians and patients. *Am Fam Physician*. 2005;72(3):463-468.
11. Kearns C, Kearns N. The role of comics in public health communication during the COVID-19 pandemic. *Journal of Visual Communication in Medicine*. Published online July 9, 2020:1-11. doi:10.1080/17453054.2020.1761248
12. Kearns C, Fisher D, Chong YS. The infective nurture of pandemic comics. *The Lancet*. 2021;397(10268):22-23. doi:10.1016/S0140-6736(20)32550-2
13. el-Setouhy MA, Rio F. Stigma reduction and improved knowledge and attitudes towards filariasis using a comic book for children. *J Egypt Soc Parasitol*. 2003;33(1):55-65.
14. Yoong Loo Lin School of Medicine. The COVID-19 Chronicles. The Covid-19 Chronicles. Accessed March 25, 2020. <https://nusmedicine.nus.edu.sg/medias/news-info/2233-the-covid-19-chronicles>
15. Morris T. The Side Eye #26: Viruses vs everyone. Three simple points about the science of Covid-19. *The Spinoff*. Published online March 25, 2020. Accessed March 25, 2020. <https://thespinoff.co.nz/covid-19/25-03-2020/the-side-eye-viruses-vs-everyone/>
16. Calder-Dawe O, Witten K, Carroll P, Morris T. "Looks like a lot of awesome things are coming out of the study!": Reflections on researching, communicating and challenging everyday inequalities. *Methods in Psychology*. 2021;5:100058. doi:10.1016/j.metip.2021.100058
17. Kearns C, Eathorne A, Semprini A, Braithwaite I, Beasley R. Public engagement with clinical research on social media; which visual medium works best? A 5-year retrospective analysis. *Journal of Visual Communication in Medicine*. Published online August 25, 2021:1-9. doi:10.1080/17453054.2021.1950525
18. Kearns C, Kearns N, Braithwaite I, et al. Using comics and curiosity to drive pandemic research on a national scale. *Journal of Visual Communication in Medicine*. Published online 2020. doi:10.1080/17453054.2020.1823206
19. Kearns C, Baggott C, Harwood M, et al. Engaging Māori with qualitative healthcare research using an animated comic. *Health Promotion International*. Published online December 10, 2020:daaa111. doi:10.1093/heapro/daaa111
20. Kearns N, Shortt N, Kearns C, et al. How big is your bubble? Characteristics of self-isolating household units ('bubbles') during the COVID-19 Alert Level 4 period in New Zealand: a cross-sectional survey. *BMJ Open*. 2021;11(1):e042464. doi:10.1136/bmjopen-2020-042464
21. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*. 2009;42(2):377-381. doi:10.1016/j.jbi.2008.08.010

22. Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: Building an international community of software platform partners. *Journal of Biomedical Informatics*. 2019;95:103208. doi:10.1016/j.jbi.2019.103208
23. New Zealand 2018 Census. Stats NZ Tatauranga Aotearoa. Published 2018. Accessed April 28, 2020. <https://www.stats.govt.nz/tools/2018-census-place-summaries/>
24. Kearns C, Kearns N, Braithwaite I, et al. Using comics and curiosity to drive pandemic research on a national scale. *J Vis Commun Med*. Published online November 18, 2020:1-11. doi:10.1080/17453054.2020.1823206
25. Code of Health and Disability Services Consumers' Rights. Published online November 6, 2021. Accessed August 5, 2021. <https://www.hdc.org.nz/your-rights/about-the-code/code-of-health-and-disability-services-consumers-rights/>
26. The COVID-19 Chronicles. National University Singapore: Yong Loo Lin School of Medicine. Published October 6, 2020. Accessed October 13, 2020. <https://medicine.nus.edu.sg/the-covid-19-chronicles/>
27. NUS YLLSOM. *COVID-19 CHRONICLES, THE Singapore's Journey from Pandemia to Peri-Pandemic Limbo*. 1st ed. WORLD SCIENTIFIC PUB; 2022.

Supplementary Material

Lay Summary

How big is your bubble?

Study title: "Characteristics of self-isolating household units ('bubbles') during the COVID-19 Alert Level 4 period in New Zealand: a cross-sectional survey"

A bit about the study..

Last year you helped out with an online study about the bubbles people were living in during the first New Zealand-wide Level 4 lockdown. This study was run by researchers from the Medical Research Institute of New Zealand, an independent research organisation, educational institute, and charity. You and 14,875 other Kiwi's from all regions of Aotearoa joined in over 6 days. That's about 1% of NZ households! There were so many responses it overwhelmed our servers briefly! The data has now been analysed and published in the British Medical Journal (BMJ) Open. This is a peer-reviewed journal, meaning multiple independent experts reviewed the work and agreed it was worth publishing. The paper is open-access meaning that anyone can now read it freely.

What did we find out together?

During the first Alert Level 4 lockdown in New Zealand in 2020 the:

- Mean bubble size was 3.58 (3-4 people)
- Mean household size was 1.26 (for every 5 bubbles, one had 2 houses in it)
- Proportion of bubbles with essential workers was 45.3% (9/20 bubbles)
- Proportion of bubbles containing vulnerable people was 42.1% (4/10 bubbles)
- Mean number of times people left their household bubble each week: 12.9 (almost twice a day). This was 25% less for those with vulnerable people in their bubble

What does it all mean?

Isolation, quarantine and lockdowns are among the oldest and most effective public health measures for controlling outbreaks of contagious diseases. They have been used successfully in the past for the 1918 influenza pandemic, and bubonic plague. By reducing all people's movements and interactions, these measures can slow disease spread and buy time for public health teams to find cases that need to be strictly isolated, and people most at risk of exposure. It also helps preserve 'healthcare capacity' or resources so that all who need additional care like ventilators can receive this.

This study adds to knowledge about an important intervention which has been part of a successful strategy in New Zealand so far, and is being used worldwide. Those taking part in the study were able to engage with and learn about the lockdown itself while considering behaviours that might cause risk to themselves and others in a pandemic. Teaming up with the public online allowed us to conduct research together from home, and rapidly collect high-level information from about 1% of New Zealand households in 6 days. This positive way of harnessing social media can be applied again to support future research on COVID-19 and other health issues of public interest.

Scientific Abstract

Abstract published in BMJ Open:

Kearns N, Shortt N, Kearns C, et al. How big is your bubble? Characteristics of self-isolating household units ('bubbles') during the COVID-19 Alert Level 4 period in New Zealand: a cross-sectional survey. BMJ Open. 2021;11(1):e042464. doi:[10.1136/bmjopen-2020-042464](https://doi.org/10.1136/bmjopen-2020-042464)

Objective: To characterise the self-isolating household units (bubbles) during the COVID-19 Alert Level 4 lockdown in New Zealand.

Design, setting and participants

In this cross-sectional study, an online survey was distributed to a convenience sample via Facebook advertising and the Medical Research Institute of New Zealand's social media platforms and mailing list. Respondents were able to share a link to the survey via their own social media platforms and by email. Results were collected over 6 days during Alert Level 4 from respondents living in New Zealand, aged 16 years and over.

Main outcome measures

The primary outcome was the mean size of a self-isolating household unit or bubble. Secondary outcomes included the mean number of households in each bubble, the proportion of bubbles containing essential workers and/or vulnerable people, and the mean number of times the home was left each week.

Results

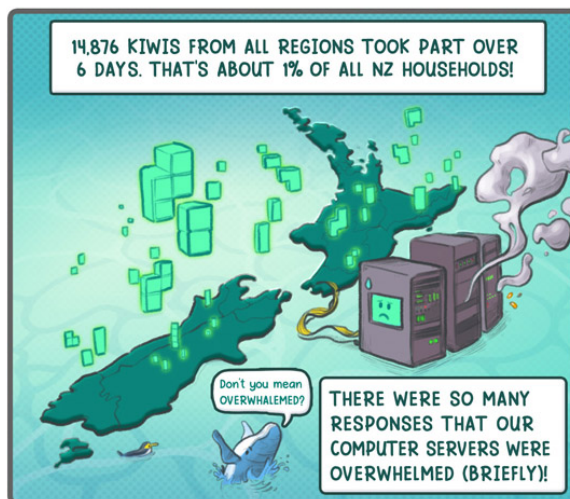
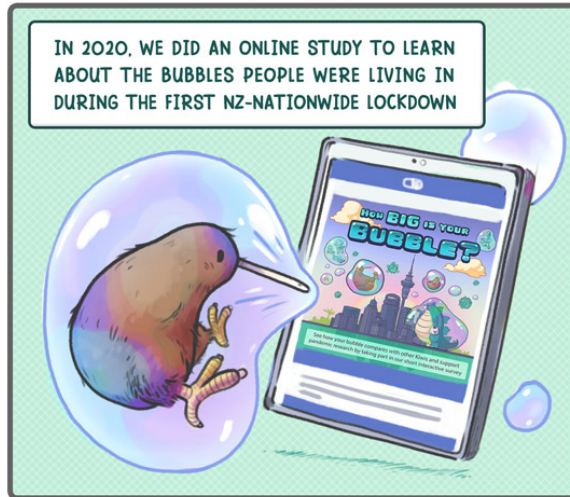
14 876 surveys were included in the analysis. The mean (SD) bubble size was 3.58 (4.63) people, with mean (SD) number of households 1.26 (0.77). The proportion of bubbles containing one or more essential workers, or one or more vulnerable persons was 45.3% and 42.1%, respectively. The mean number of times individual bubble members left their home in the previous week was 12.9 (12.4). Bubbles that contained at least one vulnerable individual had fewer outings over the previous week compared with bubbles that did not contain a vulnerable person. The bubble sizes were similar by respondent ethnicity.

Conclusion

In this New Zealand convenience sample, bubble sizes were small, mostly limited to one household, and a high proportion contained essential workers and/or vulnerable people. Understanding these characteristics from a country which achieved a low COVID-19 infection rate may help inform public health interventions during this and future pandemics.

HOW BIG ARE KIWIS' BUBBLES?

A comic research summary

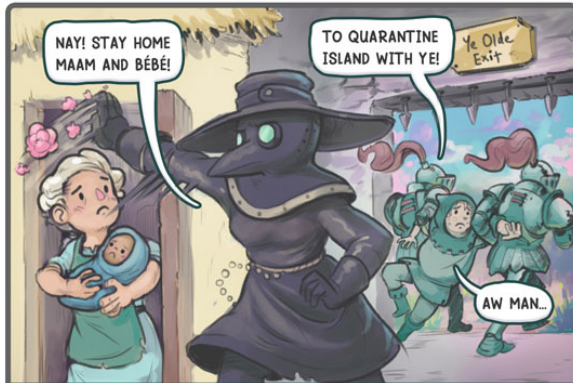


*INDEPENDENT EXPERTS REVIEWED & AGREED IT WAS WORTH PUBLISHING

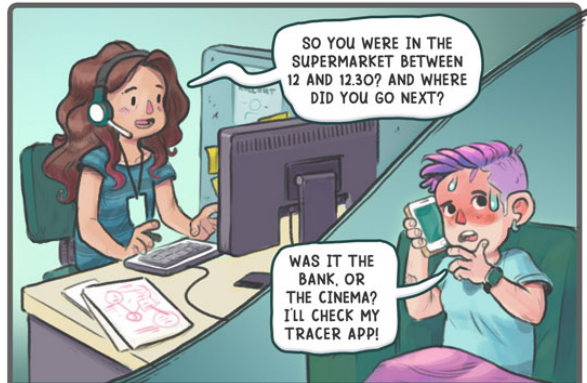
**ANYONE CAN NOW READ IT FREELY

***ART MAY NOT REPRESENT PEER-REVIEW FOR THIS JOURNAL

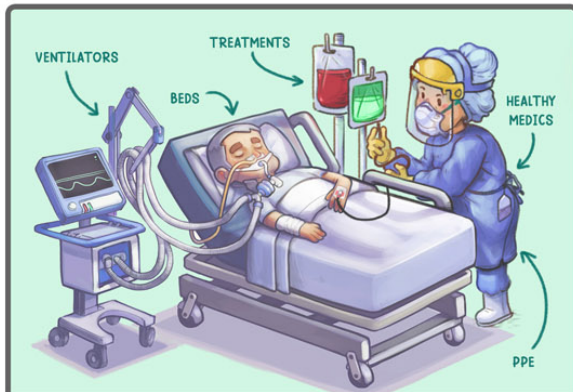
WHAT DOES IT ALL MEAN?



ISOLATION, QUARANTINE AND LOCKDOWNS ARE SOME OF THE OLDEST + MOST EFFECTIVE PUBLIC HEALTH MEASURES FOR CONTROLLING CONTAGIOUS DISEASE OUTBREAKS



REDUCING PEOPLES' MOVEMENT AND INTERACTIONS SLOWS DISEASE SPREAD, BUYING TIME FOR PUBLIC HEALTH TEAMS TO FIND AND CARE FOR THOSE NEEDING TO BE ISOLATED



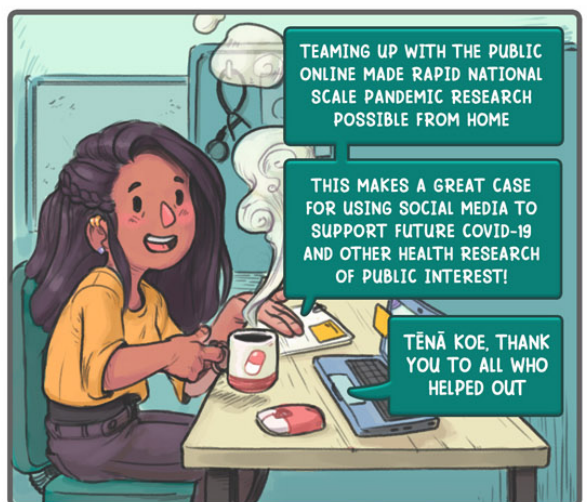
IT ALSO HELPS PRESERVE 'HEALTHCARE CAPACITY' - THE PEOPLE AND RESOURCES NEEDED TO GIVE ALL PATIENTS THE CARE THEY NEED, AND SAFELY



THIS STUDY ADDS KNOWLEDGE ABOUT AN IMPORTANT INTERVENTION WHICH HAS BEEN PART OF A SUCCESSFUL STRATEGY IN NEW ZEALAND SO FAR, AND IS BEING USED WORLDWIDE



THOSE TAKING PART COULD ENGAGE WITH AND LEARN ABOUT THE LOCKDOWN WHILE CONSIDERING BEHAVIOURS THAT COULD CAUSE RISK TO THEMSELVES AND OTHERS



TEAMING UP WITH THE PUBLIC ONLINE MADE RAPID NATIONAL SCALE PANDEMIC RESEARCH POSSIBLE FROM HOME

THIS MAKES A GREAT CASE FOR USING SOCIAL MEDIA TO SUPPORT FUTURE COVID-19 AND OTHER HEALTH RESEARCH OF PUBLIC INTEREST!

TĒNĀ KOE, THANK YOU TO ALL WHO HELPED OUT

WHAT DID WE FIND OUT TOGETHER?

SO, WHAT DID WE DISCOVER?

IN 2020, DURING THE FIRST ALERT LEVEL 4 LOCKDOWN IN NEW ZEALAND...

THE AVERAGE BUBBLE HAD 3-4 PEOPLE IN IT (MEAN 3.58)

MOST BUBBLES CONTAINED ONLY 1 HOUSEHOLD

THE MEAN WAS 1.26, SO ROUGHLY 1 IN EVERY 4 BUBBLES HAD TWO HOUSEHOLDS

ALMOST HALF OF BUBBLES HAD AT LEAST ONE ESSENTIAL WORKER (45.3%)

THOSE BEING TREATED WITH CHEMOTHERAPY OR STEROIDS

PREGNANT MUMS-TO-BE AND NEWBORN BABIES

OLDER PEOPLE, PARTICULARLY THOSE OVER 70, AND LIVING IN RESIDENTIAL CARE

I'M NOT AT RISK I JUST WANT TO PLAY WITH MY GRAM-GRAMS!

ROUGHLY 4 IN EVERY 10 BUBBLES HAD VULNERABLE OR HIGHER RISK PEOPLE IN THEM (42.1%)

ESSENTIAL WORK

SHOPPING

POP!

MEDICAL CARE

EXERCISE

FOR ME TOO!

PEOPLE LEFT THEIR HOUSEHOLD BUBBLE ROUGHLY TWICE A DAY (MEAN 12.9 TIMES PER WEEK)

THIS WAS 25% LESS FOR THOSE WITH VULNERABLE / HIGHER RISK PEOPLE IN THEIR BUBBLE