



# Motivations and Barriers to Participation in Citizen Science: The Case Study of the Hong Kong Jellyfish Project

RESEARCH PAPER

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## ABSTRACT

Citizen science projects are designed to encourage involvement of the public with science. Understanding demographics of participants and factors that motivate or create barriers to participation are central in ensuring citizen science is effective. Citizen science is not new to Asia, but its implementation is underrepresented in the published literature of that geographic area, with the current focus largely on Western countries. Here, we consider the experience of citizen scientists participating in the Hong Kong Jellyfish Project. Survey responses (N = 87) indicate demographics similar to other citizen science programs, with participant gender reflective of the general population, and participants typically in full-time employment and highly educated. The main motivating factors for participation were: the project had meaningful goals, and participants wanted to contribute to science and to learn more about jellyfish. The main barriers to participation were: not being aware that absence of jellyfish was a valid observation, lack of knowledge, and lack of time. Notably, survey responses indicate inclusive bilingual communication made the project more appealing to respondents, improved participation, and increased motivation. Interestingly, these results indicate demographic traits, motivating factors, and barriers to participation of citizen scientists in Hong Kong are similar to elsewhere, and further research should be conducted to see if the same patterns persist across other cultural contexts. Where recognized, these motivational factors and barriers can inform the design of citizen science projects to more effectively attract and engage participants.

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## INTRODUCTION

The potential for citizen science to complement academic approaches to data acquisition is gaining increasing acknowledgement. While there are many definitions of “citizen science” (Haklay et al. 2021), for this study we define citizen science as when the public engages with scientists to contribute to scientific research (Vohland et al. 2021). Citizen science is particularly effective when collecting data across large temporal or geographical scales (Dickinson et al. 2012; Thiel et al. 2014). This approach can therefore be used to effectively track large-scale patterns or irregular events such as animal population cycles, and to track invasive and rarely seen species (Dickinson et al. 2012; Pocock et al. 2018).

Although citizen science projects are important globally, their recognition and study vary across regions. The academic literature largely focuses on North America and Europe (Chandler et al. 2016), where more established organizations promote citizen science both nationally and trans-nationally (e.g., the Citizen Science Association and the European Citizen Science Association). While studies from Asia are less prevalent in the English-language academic literature, citizen science is not a new concept in this region, with projects ranging from examining trees blooming in Japan (Kobori et al. 2016), to monitoring forest resources in Cambodia (Brofeldt et al. 2018), and to documenting shark populations in Thailand (Ward-Paige et al. 2018). Some projects originated due to their cultural significance and are now being re-examined in a scientific context (Kobori et al. 2016). For example, centuries of observations of the culturally significant cherry tree blooming dates in Japanese stories have been used to infer temperature and rate of climate change over time (Aono and Kazui 2008). Despite the history of such projects in Asia, those in Western countries are typically better described in academic literature (Kobori et al. 2016). Therefore, to enhance the global contribution of citizen science, which is relatively untapped in Asia (Pocock et al. 2018), discussion is required about citizen science in different social and cultural contexts (Fan and Chen 2019).

To attract citizen scientists in a range of contexts, we need to understand the motivations and barriers to participation. From the broader volunteering literature, motivations can be both extrinsic and intrinsic (West et al. 2021). More specifically, common motivators include learning new things, helping science, social opportunities, personal or professional improvement, and feedback to participants (West and Pateman 2016; Zhou et al. 2020; Shinbrot et al. 2021; Wan et al. 2021). While research about volunteer motivations in Western countries has grown in the past decade, far less research has been published

in English-language journals about the experiences of participants elsewhere, including in Asia (West et al. 2021; but see, for example, the case of Philippine butterflies in Dem et al. 2018, or the Taiwan Roadkill Observation Network in Hsu and Lin 2021).

Factors influencing participation in conservation activities, including citizen science projects, can differ by country (Beza et al. 2017) and even across participants within a country (West and Pateman 2016), complicating participant recruitment. Cultural differences in individual and collective responsibilities may distinguish the well-studied Western context, where more individual motivations are common, from the emerging Asian studies, where collective motivations may dominate (Sakurai et al. 2015; Dashper et al. 2021). Batson et al. (2002) describe more individual motivations as egoism, where the focus is on one’s own welfare, whereas collectivism is about improving the welfare of a group. They also suggest two other motivation categories, namely altruism, having empathetic emotion towards others’ perceived needs; and principalism, upholding principles for the common good. The range of motivating factors identified within the few studies published in English-language journals specifically considering the Asian context (e.g., improving one’s learning about the topic, Dem et al. 2018; contributing to the scientific research outcomes of the project, Hsu and Lin 2021) indicate that uncertainty remains about which factors are more widespread versus culturally specific. Thus, understanding motivations in different contexts could provide practical insight to enhance participant engagement in such projects.

Even where motivated, if barriers to participation exist, individuals may not become involved with citizen science. Studies of Western programs have identified that participants involved – and therefore those who were able to overcome some barriers – tend to be older, Caucasian, of higher economic status, and educated (Pateman et al. 2021). Representation of people from lower economic and educational backgrounds may be linked to barriers that include limited knowledge, confidence, time, or disposable finances (Merenlender et al. 2016; West and Pateman 2016). Where such barriers are recognized, project proponents can reduce barriers to participation; for example, including local languages could minimize barriers related to knowledge and confidence (Spellman et al. 2019). These patterns could persist in other non-Western contexts, yet their occurrence is currently understudied. Examining barriers can provide practical insight for participant engagement, especially in Asian contexts.

In Hong Kong, a range of environmental activities are conducted by citizen scientists. The use of this approach is facilitated by CitizenScience.Asia, a registered charitable

organization supporting citizen science across Asia, and the WWF's citizen science training program for youth (WWF 2017). Observations about biodiversity can be reported to the iNaturalist platform, which is popular in Hong Kong with more than 932,000 observations submitted by more than 18,900 citizen scientists as of May 2023 (iNaturalist 2023). Citizen science approaches are being applied in local programmes monitoring the environment (e.g., marine rubbish and produce packaging, PFS 2021; light pollution, Pun and So 2012; stream water quality, Ho et al. 2020) and biodiversity (e.g., invasive Chinese Water dragons, Mo 2019; blooms of toxic red dinoflagellates in the ocean, known as red tides, AFCD 2020; jellyfish, Terenzini and Falkenberg 2022 and Terenzini et al. 2023).

While there are a range of citizen science projects in Hong Kong, the demographics, motivations, and barriers of participants are unknown. We conducted a survey of participants involved with the Hong Kong Jellyfish Project (HKJP), which was developed to document these organisms integral to marine ecosystems as both predator and prey, and which impact humans as both a food product and as a recreational hazard (Brodeur et al. 2016). We surveyed observers who contributed to the project in its first two years (from 2021 to 2023) to identify their demographic characteristics, as well as motivations for and barriers to participation. Where we better understand the motivations and barriers experienced by citizen scientists, program coordinators will be able to more effectively design projects to increase participation and enjoyment.

## MATERIALS AND METHODS

Launched in February 2021, the HKJP documents the presence, abundance, and distribution of jellyfish in Hong Kong waters (Terenzini et al. 2023). Using an internationally recognized methodology (CIESM 2014), the HKJP incorporates a bilingual (English and Traditional Chinese) website ([www.hkjellyfish.com](http://www.hkjellyfish.com)), and an iNaturalist project. These activities are promoted, and observers recruited, through traditional media (newspaper, radio), social media (Facebook, Instagram), emails, and in-person interactions (with individuals or organizations including the World Wildlife Federation [WWF], Boy Scouts, and watersports groups such as diving companies and clubs, swim groups, etc.). Observers submit sightings of jellyfish made during casual activities (swimming, walking the beach/harbourfront, taking a ferry, etc.) through a form on the HKJP website, in the iNaturalist app, or via social media or email. When they observe the presence or absence of a jellyfish, observers are asked to take photo(s) of the

jellyfish (which can be done using a smartphone and does not require specialized equipment) and submit them with simple data including the species name (if known); date, time, and location of observation; and the number and density of jellyfish individuals observed. No observer training is provided (either to individuals or in a group setting); however, observers receive species information from the project's principal investigator in response to submissions. In 2021, 395 usable observations were made, and in 2022, there were 314 usable observations. Data gained is communicated to local researchers and to the general public through presentations to schools, to societies, and to interest groups, and through peer-reviewed journal articles (Terenzini et al. 2023). Hereafter "observers" are people who submitted sightings to the HKJP, while "respondents" are those who responded to the 2021 and 2022 participation survey.

## SURVEY DESIGN

An online survey of observer demographics, motivations, and barriers was designed with reference to existing surveys (Fischer et al. 2021; Merenlender et al. 2016; Peter et al. 2021; Phillips et al. 2017). For this study, we incorporated questions focused on motivations and barriers, with some about environmental awareness and ways to improve the HKJP. The survey consisted of 26 closed-ended Likert scale questions and 2 open-ended questions for a total of 28 questions (see Supplemental File 1: Compiled Hong Kong Jellyfish Project translated outreach letters and participation survey questions for the full list of questions). Scale questions were chosen instead of open-ended questions so that respondents would be more likely to respond to all questions without getting survey fatigue. Questions were divided into the following categories: demographics, nature connectedness, project participation, barriers to participation, feedback and communication, and improving the HKJP.

The survey was written in English and translated into Traditional Chinese. Both English and Traditional Chinese are commonly used in Hong Kong, with 88% of Hong Kong residents stating their written Chinese was sufficient for daily use, while 45% said that for written English (CSD 2022). Both languages are often included on documents, with the choice of language used frequently based on perceived personal proficiency and language preference of the person receiving the message (CSD 2022).

The HKJP is an independently funded and operated project outside of an academic institution, so no formal ethics review of the research methodology was conducted by a committee; however, survey standards of the British Educational Research Association's Ethical Guidelines (BERA

2018) were adhered to when designing and executing the survey. In the invitation and survey forms, respondents were informed of the survey's purpose, goals of the HKJP, and that research output dissemination may include academic publication. The invitation stated that the survey design had multiple-choice closed-answer and open-ended questions; no personally identifying information would be collected (names, phone numbers, etc.); and the resulting data would be used only in aggregate and would follow the HKJP data privacy policy, which includes information about data retention (with a link to that policy provided). No incentives were offered for participation. The e-mail contact for the principal investigator was included in case potential respondents wanted further information about participating in the survey. Respondents were informed that by taking the survey they were giving their consent, and even if they'd started the survey, they could withdraw consent by exiting the survey at any time with no need to inform the principal investigator. This was, therefore, an opt-in approach.

## RESPONDENT POOL

Bilingual invitations to fill out the survey were sent in 2021 and 2022 to observers who submitted observations to the HKJP website (149 and 73 invitations in 2021 and 2022, respectively) and whose sightings were collected by the iNaturalist project (90 and 75 invitations in 2021 and 2022, respectively). All invitations were bilingual (English and Traditional Chinese) and included links to the English and Traditional Chinese surveys, with the survey form piloted with English and Traditional Chinese language users to check clarity and comprehension. The 2021 survey links were open from Wednesday, December 1, 2021 to Wednesday, December 22, 2021; and the 2022 survey links were open from Wednesday, November 30, 2022 to Wednesday, December 21, 2022. The resulting, anonymized data is available at the Zenodo link provided in Supplemental File 2: Hong Kong Jellyfish Project 2021 participation survey answers dataset and Supplemental File 3: Hong Kong Jellyfish Project 2022 participation survey answers dataset.

## ANALYSIS

Twenty-six questions with a 5-point Likert scale were used for quantitative data analysis. Descriptive statistics (frequency) was used to analyze general participant demographics and motivations and barriers to participation through the lenses of age and gender. Respondents answering "agree" or "strongly agree" are said to agree with a statement. Percentages are rounded to the nearest whole percent. Analysis was done using SPSS 28.

## RESULTS

Of the 239 invitations sent out in 2021, 36 English and 24 Traditional Chinese responses were received for a total of 60 responses (25% response rate). For the 2022 participation survey, of the 148 invitations sent, 11 English and 16 Traditional Chinese responses were received for a total of 27 responses (18% response rate). The combined number of respondents is, therefore, 87.

### RESPONDENT CHARACTERISTICS

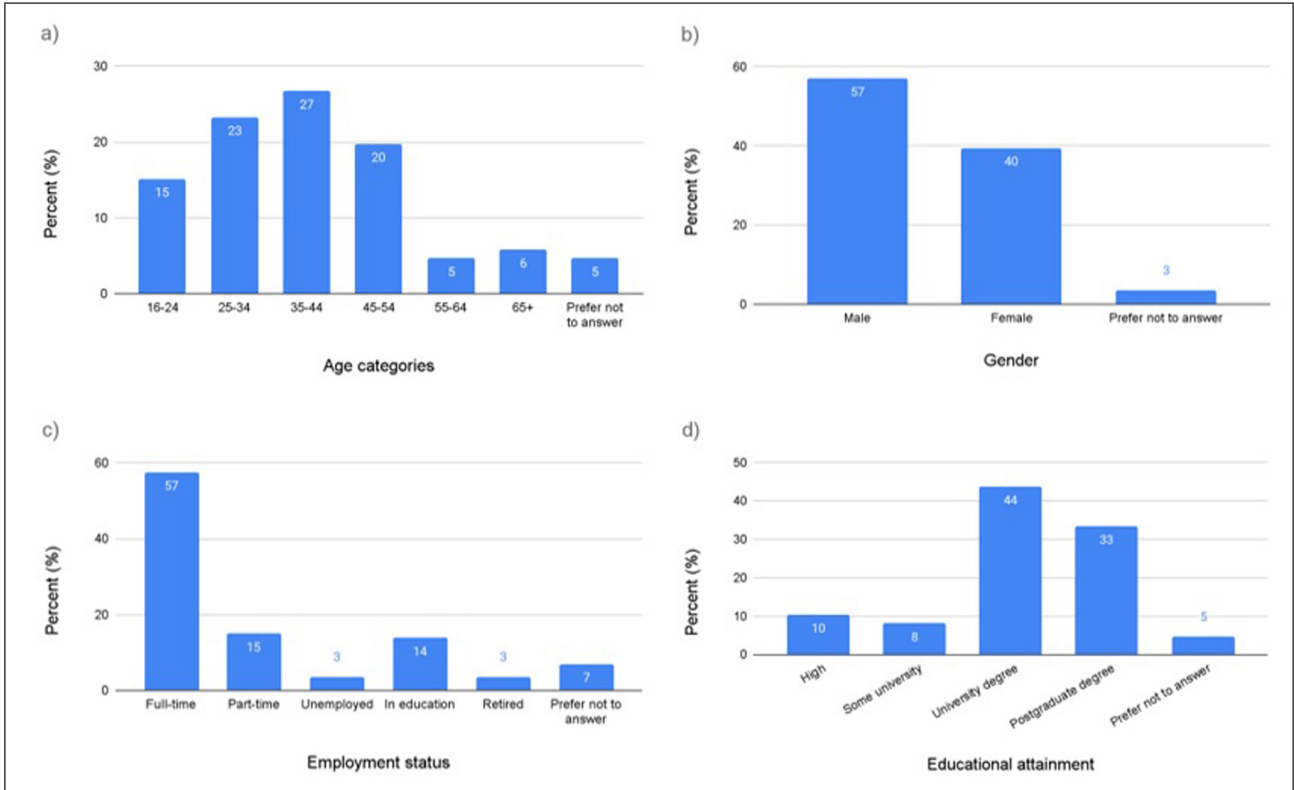
There were limited repeat observers between 2021 and 2022 as determined by email addresses for website users and login names for iNaturalist users. Of the observers who responded to the survey, 50% were in the 25–34 and 35–44 age categories (Figure 1a). Overall gender of respondents skewed slightly towards males (57%; Figure 1b). The majority of respondents were full-time employed (57%), with the next most common categories part-time employed (15%) and in education (14%; Figure 1c). Over 75% of respondents had received higher education, with 44% and 33% having university and postgraduate degrees, respectively (Figure 1d).

### MOTIVATIONS TO PARTICIPATE

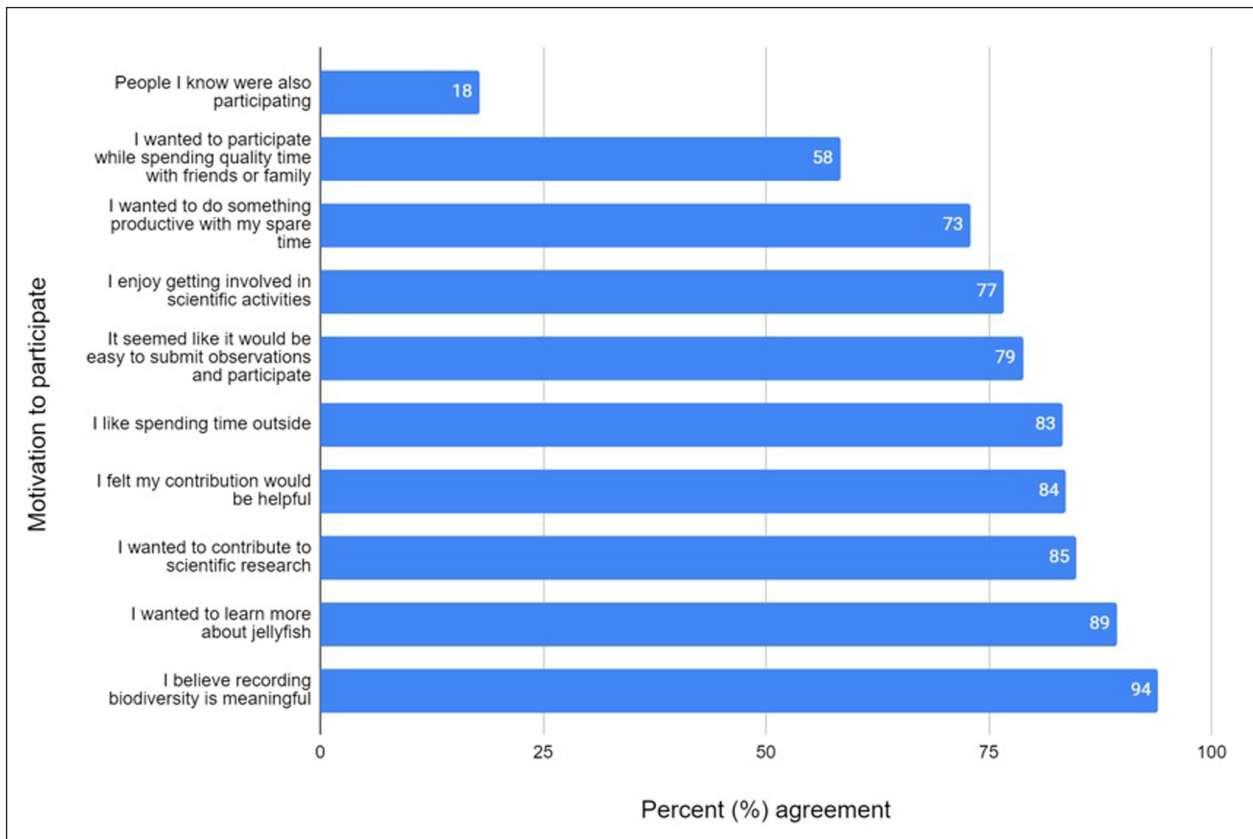
The top motivations perceived by respondents were their belief that the project had meaningful goals/recording biodiversity is meaningful (94%), their desire to learn more about jellyfish (89%), and their desire to contribute to science (85%; Figure 2). Many of the other motivations also received high positive responses (> 70% agreement). While over half of all respondents (58%) said they wanted to participate to spend time with family and friends, less than one fifth (18%) were involved because someone they knew was participating (Figure 2).

When considered in terms of respondent age, there was consistency in the proportion of agreement with the top three motivations across age groups, although those within the 35–44 category showed the least agreement (Figure 3a). The greatest difference was about wanting to learn more about jellyfish; 100% of respondents in the 55–64 and 65+ categories and 95% of the 25–34 year olds agreed, whereas just 77% of participants aged 35–44 did. Of the age categories, the 35–44 age category consistently had the lowest level or second lowest level of agreement to all motivations except "I like spending time outside" for which the category had the highest level of agreement at 91%.

When responses were examined by gender, females (94%) were more likely to want to "learn more about jellyfish" than males (85%), while the position was reversed



**Figure 1 Respondent demographic details.** Proportion of survey respondents within each: (a) age category (n = 86). (b) gender (n = 86). (c) employment status (n = 87). (d) educational attainment level (n = 87). Note different y-axis scales.



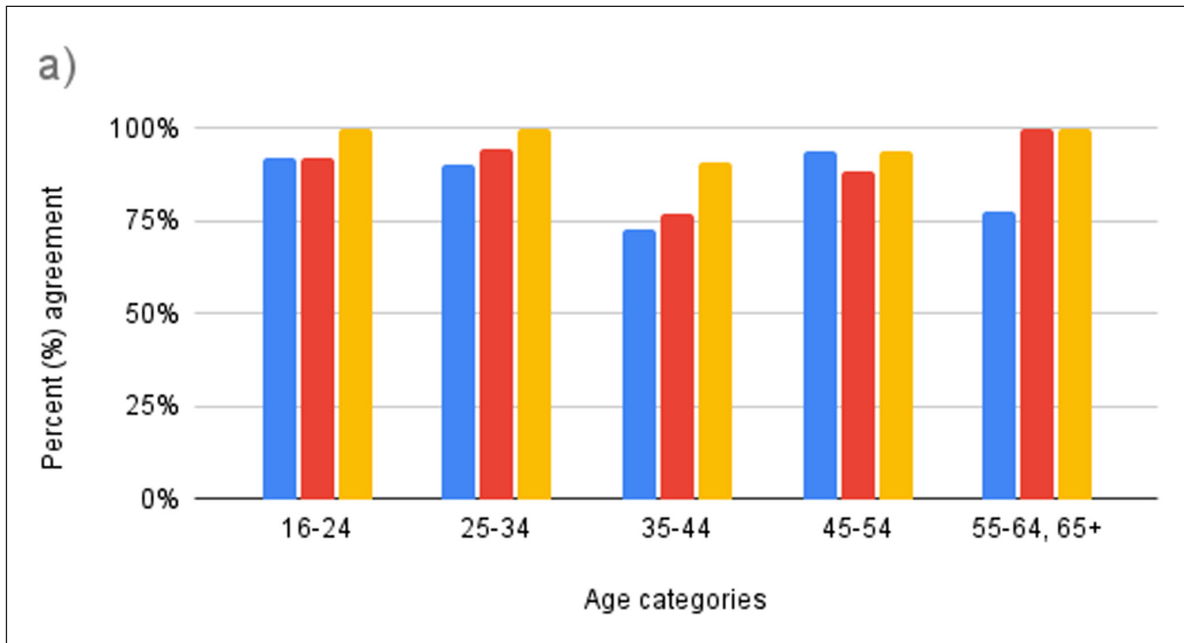
**Figure 2 Motivations to participate in the HKJP.** Proportion of survey respondents who agreed with each motivation to participate.

for thinking that “the project has meaningful goals/ recording biodiversity is meaningful,” with 98% of males agreeing and 88% of females agreeing (Figure 3b).

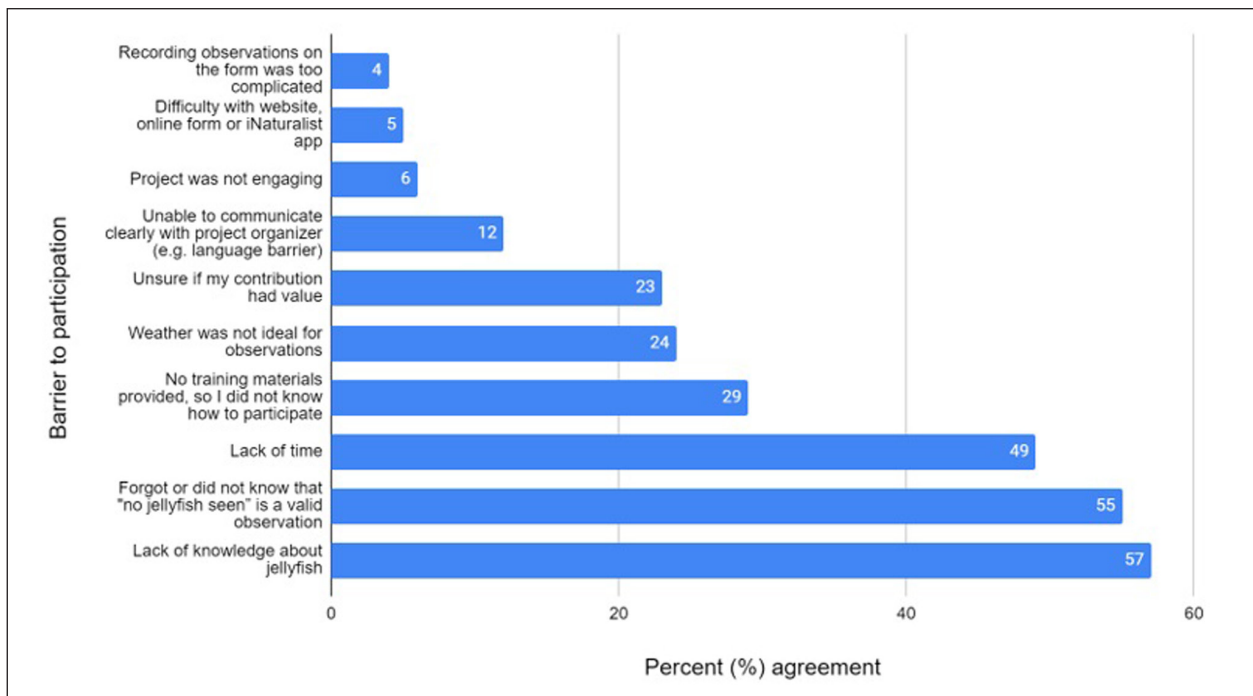
**BARRIERS TO PARTICIPATION**

The three barriers to participation with the greatest proportion of participant agreement were: lack of

knowledge about jellyfish (57%), lack of awareness that absence (i.e., “no jellyfish”) was a valid observation (55%), and lack of time (49%) (Figure 4). More than a quarter of survey respondents (29%) felt a lack of training was a barrier to participation. Following these were barriers related to weather, perceived value of contribution, language, project engagement, technology issues, and project complexity.



**Figure 3 Agreement regarding the top three motivations to participation across key demographic groups.** Proportion of survey respondents within each: (a) age category (n = 86). (b) gender (n = 86).



**Figure 4 Barriers to participation in the HKJP.** Proportion of survey respondents who agreed with each barrier to participate.

While all age groups had some agreement that a lack of knowledge was a barrier, the greatest agreement came from the 25–34 year olds (75%), with the least agreement in the 45–54 age group (29%). Not knowing “no jellyfish” was a valid sighting was the highest in the 25–34 category (75%), whereas this was least in the categories of 55–64 and 65+ (29%; [Figure 5a](#)). A lack of time was a barrier to participation for 68% of 35-to-44-year-olds, the highest percentage across all age categories. Over half of the participants in each of the categories less than 35 years of age also agreed time was a barrier. This barrier had less agreement in the older age group ([Figure 5a](#)).

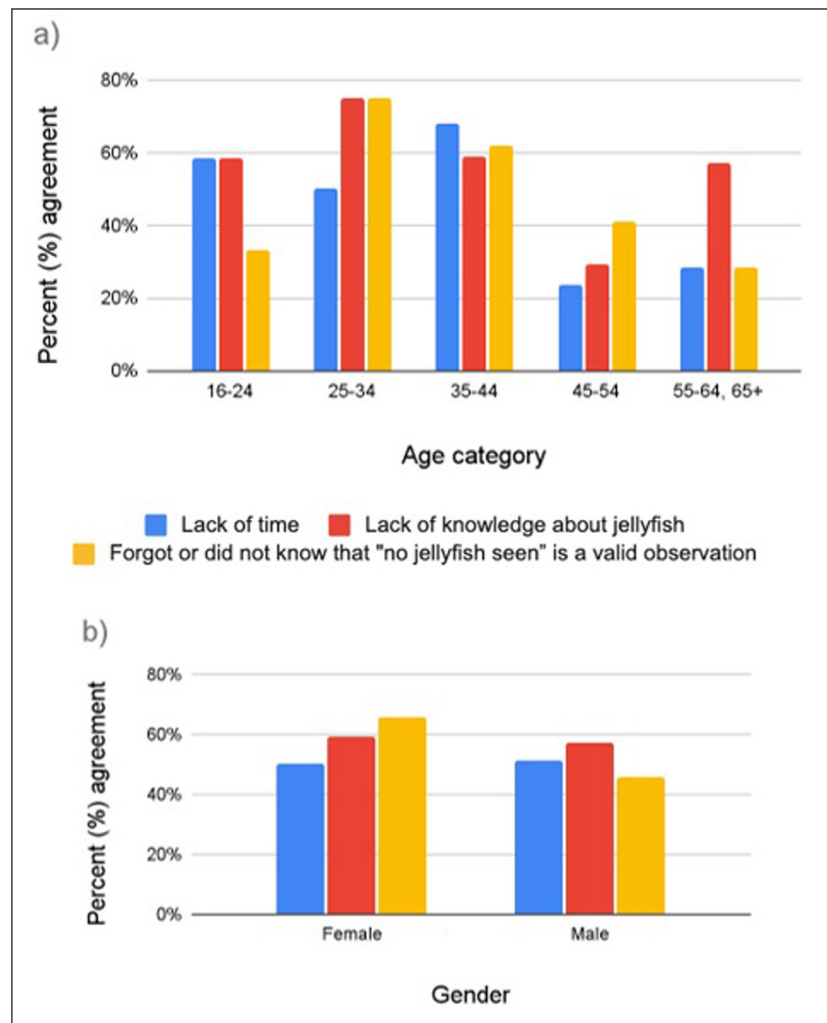
There was some difference between males and females in what they considered to be barriers to participating in the HKJP ([Figure 5b](#)). Of the top three barriers, not knowing that “no jellyfish” was a valid observation was a barrier for female participants at an occurrence of 1.4 times that of male participants, while lack of knowledge and lack of time were almost the same.

### BILINGUAL COMMUNICATION

The bilingual forms of the website made the project more appealing to 57% of respondents, while 42% said it made no difference. For the bilingual iNaturalist journal entries, 54% selected that they appealed more and 44% that it made no difference. For all percentage total values, the remaining percentages consisted of people who did not answer the questions.

The project principal investigator is not able to communicate in written Chinese, so responses to website queries and submissions were in English. The vast majority of survey respondents stated that this did not affect their participation (84%). Of the remainder, 15% said that responses being written in English made them want to participate more, and 1% said the English responses made them want to participate less.

Over 60% of respondents between the ages of 16 and 34 (the two youngest age categories combined) thought bilingual outreach methods on the poster and website



**Figure 5** Agreement regarding the top three barriers to participation across key demographic groups. Proportion of survey respondents within each: (a) age category. (b) gender (female n = 34, male n = 49).

made the project appeal more. This appeal decreased for those in the 35–44 age category, with only 36, or 45%, saying the bilingual poster and website, respectively, appealed to them more, with the majority saying it made no difference.

Males showed a higher preference for the bilingual approach across all mediums of project outreach. Over 60% of male respondents said bilingual outreach methods made the project appeal more, while this was 40% for females. There was very little difference in the male and female preferences for the use of English and Traditional Chinese for reading and writing, with 47% of males and 53% of females preferring English, with 51% of males and 47% of females preferring Traditional Chinese. There was one person who did not respond to this question.

## DISCUSSION

Our survey of HKJP observers allowed us to gain an understanding about who is participating, and their perceived motivations and barriers. In terms of demographic composition compared with the general population, our respondents had a similar gender proportion, skewed slightly younger, and were mostly full-time employed and highly educated. Key motivating factors included feeling the project had meaningful goals, wanting to learn more about jellyfish, and wanting to contribute to science. Key barriers included lack of knowledge, lack of awareness that absence was a valid observation, and lack of time. It is important to note these trends are drawn from a small number of respondents ( $N = 87$ ), and care should be taken in their extrapolation. Together, these results provide a unique insight to Hong Kong's citizen scientists, with them reporting motivations and barriers similar to those identified elsewhere (i.e., those in Western and east Asian contexts), which are patterns that should be considered further.

As background for our survey responses, it is useful to understand the patterns of observations and respondents. Interestingly, there were more observers submitting to the project in the first year (2021) than in the second (2022), with this reflected in the number of surveys sent and responses received. The change is likely due to restrictions placed on public gatherings, beaches, and movement to work due to the COVID-19 pandemic, which worsened in Hong Kong during 2022 (discussed further below). Relatedly, there were a limited number of repeat observers between 2021 and 2022, with most (~ 80%) contributing a single observation, a common pattern in citizen science projects (Sauermann and Franzoni 2015). Such patterns may indicate a single observer (using the website) with

multiple email addresses, discontinuation of the survey the year prior, and the impact of emigration. Regardless of the cause, by considering respondents to surveys distributed in both years, we were able to increase the sample size (although this remained relatively small at  $N = 87$ ). Given these patterns of contributions, understanding the demographics, motivations, and barriers of observers will be important to ensure consistent reporting.

When considering the demographics of our respondents, one trait that aligned with that of the general population was gender. Although there were more male than female survey respondents, this was not significantly different to the general population ( $p = 0.152$ ) (CSD 2021a). Such a result aligns with previous research which has identified no known set patterns of participation in citizen science by gender (Pateman et al. 2021).

Our survey respondents were generally younger than the average Hong Kong citizen. The majority of respondents were in the 25–34 and 35–44 age categories, whereas the Hong Kong population median age was 46 years old (CSD 2021b). A number of factors can contribute to such patterns. One is that citizen science is used more frequently in education in Hong Kong (Ho et al. 2020), which may skew participation towards younger groups. Additionally, the method of invitation may have shaped participation. That is, younger people's participation can increase with social media invitations, while older participants can be more effectively reached through targeted invitations (Brouwer and Hessels 2019). The HKJP participation survey was sent out to email addresses collected from website submissions and through iNaturalist messaging. This approach may skew the response population away from younger participants.

A notable feature of our demographic results is the lack of retirees. This result differs from other citizen science studies in which there tended to be higher numbers of retirees (Pateman et al. 2021). Such a pattern may be due to decreased relevance of characteristics that can cause skew towards older participants because this project did not require a lot of free time (there were no set training sessions to attend) or travel to specific sites (and related financial resources) (Pateman et al. 2021). Moreover, as Hong Kong's retirees typically have lower educational and socioeconomic levels, and greater cultural expectations to be caregivers (Tsien and Ng 2010), their capacity to participate in citizen science may be restricted. Finally, this study was conducted during the COVID-19 pandemic. Notably, during the spring of 2022, Hong Kong had the highest death rate of elderly people in the world (Taylor 2022). This may have limited older people's participation in a citizen science project requiring them to be outside of their homes.



Our survey respondents tended to have full-time employment and to be highly educated. Although respondents skewed heavily towards full-time employment (57%, compared with 58% in the population; [CSD 2023a](#)), all employment statuses were represented (part-time-respondents, 15%: population, 9% [[CSD 2023a](#)]; unemployed respondents, 3%: population, ~4% [[CSD 2023b](#)]). The low number of respondents (N = 87) makes it hard to draw definitive comparisons between the respondents and the general population. Western studies suggest underrepresentation of part-time or unemployed participants in citizen science could reflect their limited means, such as time and money, to participate ([Pateman et al. 2021](#); [West and Pateman 2016](#)). The similarity between the respondents' and population patterns may indicate this was a project accessible to a broad range of people across employment types.

Respondents' educational demographics differed from that of the general Hong Kong population's. University degree holders made up 44% of respondents and postgraduate degree holders made up 33%, totaling 77%. This proportion is three times greater than found in Hong Kong's general population, where 26% have a university degree ([CSD 2021b](#)). This finding aligns with other studies showing citizen science participants generally have higher levels of education ([Pateman et al. 2021](#); [Shinbrot et al. 2021](#)). A lack of experience with science from lower levels of education may impede participation ([Merenlender et al. 2016](#)). Additionally, citizen science projects that use a generic invitation strategy tend towards higher-education-level participants, while a more targeted invitation strategy can increase participation from those with lower education levels ([Brouwer and Hessels 2019](#)). Here, we used a generic invitation email to all observers who submitted to the HKJP website and iNaturalist project. In the future, efforts can be made to further involve observers with lower levels of formal education by focusing recruitment methods toward underrepresented groups ([Pateman et al. 2021](#)).

While covering a range of demographics, many respondents agreed that the same features of the HKJP motivated their involvement. The three top motivations respondents agreed upon were: because they thought the project had meaningful goals/believe recording biodiversity is meaningful (94%), they wanted to learn more about jellyfish (89%), and they wanted to contribute to science (85%). These motivations are similar to those for other marine citizen science projects ([Lucrezi et al. 2018](#); [Thiel et al. 2014](#)) including projects conducted in this region (i.e., Asia; learning and contributing to research were influential motivators in [Hsu and Lin 2021](#)). Interestingly, these motivations align with the four categories of motivation proposed by [Batson et al. \(2002\)](#) of egoism, collectivism,

altruism, and principalism, which cover a broader range of motivations than identified in a previous study of Chinese volunteers ([Dashper et al., 2021](#)). Our Hong Kong data show the top three factors are stable and vary little across the age groups, which contrasts with an American-based finding where younger volunteers have more extrinsic and egoistic motivations, and older volunteers more intrinsic and altruistic motivations ([Clary and Snyder 1999](#)).

The social components amongst motivating factors varied. Only ~20% of respondents knew someone else participating in the HKJP, which motivated their engagement, while almost 60% noted motivation came from wanting to spend time with friends and family. As this project relies on observations of opportunistic biodiversity sightings, observers could report jellyfish while engaged in other social activities, thereby making participation flexible to one's social circumstances. The relatively low proportion of respondents motivated by knowing someone else in the project may be a reflection of project outreach, in that no social or training sessions to bring observers together were organized. Restrictions during the COVID-19 pandemic impacted social opportunities across Hong Kong in 2021 and 2022. The government closed beaches and banned groups of more than 2 people in public, limiting social gatherings and activities. These restrictions would have impacted social marine activities (boating, diving, kayaking, etc.) that could lead to observations. With restrictions lifted, social aspects may be a greater motivator in the future, with potential for citizen science to be an engaging social activity.

Respondents also reported barriers to participating in the HKJP. The top three barriers were a lack of knowledge, not being aware that an observation of absence was valid (i.e., "no jellyfish"), and a lack of time. It is important to note, however, that these are barriers identified by observers involved in the HKJP. It is probable that if we contacted individuals who had not made observations, their barriers would have been different and/or greater (which prevented their involvement). Considering similarities or differences in responses of these two groups could be an interesting area for future work in an Asian context, to complement comparisons carried out by [Pateman et al. \(2021\)](#) in the United Kingdom.

In agreement with other citizen science participation studies, a lack of knowledge and time are frequently reported as a barrier to participation ([Martin et al. 2016a](#); [Merenlender et al. 2016](#); [West and Pateman 2016](#); [Shinbrot et al. 2021](#)). These studies suggest that citizen scientists are those who would be entering with a reasonable interest in, and understanding of, the scientific process ([Martin et al. 2016b](#)). Many people frequently cite wanting to learn more about marine species as a motivation ([Hermoso et](#)

al. 2020) and are then often willing to invest significant resources, including time, in projects (Martin et al. 2016b). However, time was noted as a barrier to participation here. In our study, lack of time had the greatest agreement in the 35–44-year-old category, aligning with previous studies that found younger groups were more likely to invest time in careers and growing families, and thereby have less time to participate in citizen science (Pateman et al. 2021). It is worth noting lack of time and a lack of knowledge were identical barriers for females and males. These results have implications for citizen science organizers pursuing inclusion as it indicates which barriers need to be overcome. As knowledge of the scientific process and the topic being considered are key factors shaping participant involvement, project proponents should ensure there are learning and feedback opportunities for participants when designing projects, which can increase participation (Zhou et al. 2020). Since time was considered a barrier for most age cohorts, designing projects for flexible levels of participation would allow participants to engage when they are available. Such efforts in communication and project design can also be used to encourage participation in underrepresented groups.

A barrier more specific to the design of this type of citizen science project was not being aware that reporting an absence (i.e., “no jellyfish”) was valid. Interestingly, many respondents shared they were unaware they could participate by submitting a record of jellyfish absence, which implies the vast majority submitted a presence record. This response is interesting given the option for reporting jellyfish absence is explained on project materials (i.e., poster and website). A request for “no jellyfish” sightings is written on the main page of the website and is possible via the website observation form; however, there is no mechanism on the iNaturalist platform to report no jellyfish. Citizen scientists can bias towards positive sightings, and projects frequently lack “absence” data (Weigelhofer and Pölz 2016).

In certain locations, such as Hong Kong, bilingual strategies should be considered when conducting and assessing citizen science projects. The use of language in Hong Kong is a complex topic because of the abundance of Traditional Chinese, the common language of Hong Kong; the increasing occurrence of Simplified Chinese, the common written language of mainland China; and the historical presence of English, and its use by many of the Western immigrants to Hong Kong. In Hong Kong, it is common for people to speak two or three languages (Cantonese, Mandarin, English) with varying fluency, and street signs and public documents are frequently in two languages (Traditional Chinese and English). By deliberately having project materials, website, and initial submission forms (via the website and iNaturalist entries) in Traditional

Chinese and English, we allowed observers to choose the language with which they are most comfortable. While the English-language response of the project organizer (their language of greatest fluency) made participating in the HKJP more challenging for 12% of respondents, promisingly 84% of respondents said the English response did not negatively affect their ongoing participation. Addressing this barrier in the HKJP would require an additional team member who could correspond in Traditional Chinese.

The importance of bilingual outreach in participatory programs will, however, be dependent upon the observers and context considered. For example, in our study, we identified differences across age categories, where 35–44 year olds were the most likely to say bilingual outreach made no difference, while respondents from younger age categories said it made the project appeal more. With the changing dominance of different languages over time in Hong Kong, this could influence how participation of individuals belonging to different age groups is affected by the project outreach language(s). While translations increased project costs and preparation time, these results demonstrate the utility of providing forms in Traditional Chinese and English. These positive findings could encourage others to consider bilingual outreach when designing and executing projects. Additionally, longitudinal research could be done to investigate the influence of changing language use and proficiency on participation in citizen science, with an assumption that benefits gained from bilingual project materials will shift alongside the language landscape.

While many citizen science analyses discuss the need to reach out to underrepresented groups and demographics, specific courses of action are often lacking. A multilingual place such as Hong Kong provides an opportunity to demonstrate how bilingual outreach benefitted project perceptions. Although many countries will have a dominant language, incorporating other languages can potentially lead to the inclusion of perspectives that may otherwise be excluded (Spellman et al. 2019). Project proponents will have to assess the costs and benefits of language inclusion based on the type of project they envision, available funding for translation costs, available time for outreach materials to be created, available staff or volunteers capable of communicating in the languages used, and assessments of what value bilingual inclusion will bring to the project.

While there were some distinct characteristics of our citizen science project, particularly related to its bilingual nature, many observer motivations and barriers broadly align with other studies, including those from Western and Asian contexts. It is worth noting that this is a single Asian case study, and Hong Kong’s history as a British colony and the large number of Western immigrants here could

make the motivations and barriers more similar to those found in Western contexts. To better understand nuances in similarities and differences of Western and Asian citizen science studies examining participation, we propose further research should be carried out across Asian countries to determine which factors are acultural versus culturally-specific. Locally, now that we recognize the broad patterns of citizen science motivations and barriers for this Hong Kong-based project, further research could be done to examine these patterns and why they occur in more detail by considering (i) socio-cultural identities, (ii) values about volunteering, and (iii) who is not participating in citizen science projects.

## CONCLUSION

The demographics of, and reasons for, people becoming citizen scientists are increasingly known, though further research is needed to explore a range of cultural contexts. Our respondents had similar demographic characteristics to those in other citizen science projects in terms of being employed and highly educated. In contrast to Western studies showing strong participation from retirees, most respondents in our study were still working, which may speak to the ease of participation in the project design, particularly as impacted by COVID-19. Top motivations for participation were comparable to those intrinsic and extrinsic motivating factors identified in Western and some Asian studies, specifically the meaningfulness of the project and of recording biodiversity (principalism and altruism), the desire to learn more about jellyfish (egoism), and the desire to contribute to science (altruism and collectivism) (Batson et al. 2002). While the overall motivating factors appear acultural, these factors were stable across our study participants, which differed to Western research, which showed a shift from extrinsic to intrinsic motivations as participants age. Top barriers to participation were lack of knowledge, not realizing the absence of a jellyfish could be reported, and lack of time. Future efforts could be focused on providing learning opportunities and educational materials, incorporating additional ways to be involved in scientific research (e.g., regular field surveys), and emphasizing how seeing “no jellyfish” is a valid contribution. The bilingual outreach in both English and Traditional Chinese was an appealing factor for participation and should be enhanced. A follow-up study evaluating motivations and barriers to participation could be conducted after a few more years of project activity, enabling a longitudinal study that could help determine if and how changes to the project based on current findings have made an impact over time. Project proponents should consider potential participants and their

cultural and linguistic preferences when designing projects and conducting outreach. Where sociocultural traits are better understood, this could enhance our understanding of motivations and barriers faced by citizen scientists and increase inclusivity of scientific research.

## DATA ACCESSIBILITY STATEMENT

Survey questions with translations, outreach letters with translations, and survey response data files (Supplemental Files 1–3, below) can be found in the Supporting Information on Zenodo at <https://doi.org/10.5281/zenodo.8138056>.

## SUPPLEMENTAL FILES

The supplementary files for this article can be found as follows:

- **Supplemental File 1.** Compiled Hong Kong Jellyfish Project translated outreach letters and participation survey questions. DOI: <https://doi.org/10.5334/cstp.618.s1>
- **Supplemental File 2.** Hong Kong Jellyfish Project 2021 participation survey answers dataset. DOI: <https://doi.org/10.5334/cstp.618.s2>
- **Supplemental File 3.** Hong Kong Jellyfish Project 2022 participation survey answers dataset DOI: <https://doi.org/10.5334/cstp.618.s3>

## ETHICS AND CONSENT

We confirm that this study was performed in accordance with the Declaration of Helsinki, and that the identity of each research subject has been anonymized.

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## COMPETING INTERESTS

John Terenzini is the founder and principal investigator of the Hong Kong Jellyfish Project. Laura Falkenberg has been

an academic advisor throughout the course of the Hong Kong Jellyfish Project.


## AUTHOR CONTRIBUTIONS


John Terenzini: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, visualization, writing of original draft, reviewing, and editing.

Smriti Safaya: conceptualization, data curation, formal analysis, investigation, methodology, resources, software, validation, visualization, and reviewing and editing of the manuscript.

Laura J Falkenberg: conceptualization, investigation, supervision, visualization, and reviewing and editing of the manuscript.

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