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Age-related mobile digital divide in citizen science: the CSMON-LIFE experience

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SUMMARY

The amount of available Citizen Science data has increased significantly in the last two decades and has been used in several biogeographic studies as well. Citizen Science data are mostly collected through digital platforms, and especially mobile Apps. While the adoption of novel Information and Communications Technology (ICT) approaches potentially allow for a wider participation, recent studies have highlighted that the ability of making an intensive use of smartphones and mobile apps could decrease with users' age. At the same time, data quality and commitment of volunteers in citizen science activities often increases with the age of volunteers. During the CSMON-LIFE (Citizen Science MONitoring) project volunteers provided their year of birth, thus allowing for inferences on the relation between age and data quality and retention rate. In this manuscript, a further investigation is carried out for understanding the potential effect of the digital gap that exists especially between young adults and old adults on participation to citizen science activities. In the case of CSMON-LIFE, older age classes are under-represented, if compared to the overall Italian population. While the difference cannot be with absolute certainty ascribed to one factor alone, it can be hypothesized that a relevant contribution to the limited participation of old adults could be due to the intensive adoption of mobile Apps. Furthermore, it seems that choice of mobile devices among volunteers is quite different from that made by the average population based on availability in the Italian market, possibly evidencing an overall higher education of citizen scientists. Therefore, it can be said that digital divide can have a negative effect on the participation of volunteers belonging to the older age classes, even if this effect will probably slowly disappear in the future.

INTRODUCTION

In the last two decades the amount of citizen science data—especially in the field of biodiversity—has increased significantly (Bonney et al., 2014). It has also been demonstrated that volunteers can also collect high-quality data (Delaney et al., 2008; Jordan et al., 2012; Lewandowski and Specht 2015; Kosmala et al., 2016), which can also be used for increasing the amount of data available for biogeography studies (Devictor et al., 2010). In the last decade, several biogeographic studies made use of citizen science data (Barahona-Segovia et al., 2021; La Sorte & Somveille, 2021), demonstrating the strategic added value that citizen science can provide to this area of research, also in exploring the distribution of alien invasive species (Lo Parrino & Tomasi, 2021; Nimis et al., 2019). Wang Wei et al. (2016), in a wide review, analyse the contribution of volunteers in the study of urban populations of birds and butterflies, stressing the issues related to the use of citizen science data, and highlighting its yet underexploited potential. Suprayitno et al. (2017) highlighted that the use of modern social networks can greatly improve public participation, as well as the sharing of information, thus increasing the opportunity of collecting useful data.

Citizen Science data are today mostly collected through digital platforms, and especially mobile Apps, such as iNaturalist (Matheson, 2014), which is probably the most important contributor of occurrence records to the GBIF (Global Biodiversity Information Facility, https://www.gbif.org). New technologies allow for a wider participation, given that - at least in developed countries - smartphones are more or less part of everyday's life. Furthermore, since data collected through Apps are natively digital, they are immediately usable for digital platforms and aggregators, and can be shared with the scientific community in real time. However, recent studies, especially in the field of digital health monitoring, have highlighted that the use of smartphones and mobile Apps could decrease with users' age. A research in the UK shows that old adults are mostly keen to use (or are planning to adopt) smartphones (Choudrie et al., 2020), thus potentially including these citizens in any citizen science project adopting a digital platform. However, the use of e-services and of social networks on smartphones is strongly affected by two factors, i.e. education level and age (Elena-Bucea et al., 2021). Another study evidenced that, in low-income, racial and ethnic minorities, younger age is significantly associated with a more intense use of social media and Apps (Kumar et al., 2019). A recent study in China further stresses the relevant digital divide between age classes in the population, evidencing that old adults are least likely to intensively use smartphones, especially for Apps and browsing (Wang et al., 2021). At the same time, it has been demonstrated that often data quality and commitment of volunteers in citizen science activities vary with age (Martellos et al., 2021), with older age volunteers been retained for longer periods, and collecting more reliable data. Thus, could the digital divide have some consequences in the data quantity and quality collected through citizen science digital platforms?

In this study, participation limitations to citizen science activities deriving from the adoption of digital platforms for the submission of observations by volunteers are discussed on the basis of the data collected during the CSMON-LIFE (Citizen Science MONitoring) project (LIFE13 ENV/IT/842, Martellos et al., 2021).

MATERIALS AND METHODS

Data were obtained during the project CSMON-LIFE, starting from December, 2014 to December, 2020. The first 3 years (Dec 2014 - Dec 2017) were part of the funded period of the project, while the last 3 years (Dec 2017 - Dec 2020) were part of the so called after-LIFE period, for which the project did not receive any further funding from the EU Commission.

The users at the moment of their subscription for using the App or WebApp of CSMON-LIFE provided their personal data: first and family name, and year of birth. Further data were provided with each observation submitted to the system, and were: geo-location of the observation, date, scientific name (if available), and an image of the observed organism. Users sometimes submitted short notes as well. Data on the adopted platform (App for Android OS or iOS, or WebApp) were submitted together with each observation as well.

Among the ca. 20 thousand volunteers which participated to the diverse project activities, only the data of those which registered to the system for submitting observations (cs. 4500) and did not delete the registration during the duration of the project were used. Furthermore, all the volunteers which did not provide valid data (e.g., incorrect year of birth) were removed from the analysis, which was carried out on a total of 1373 volunteers (Tab. 1).

Table 1. Distribution of participants to CSMON-LIFE per age classes, compared to Italian population. Absolute numbers and percentages are reported.

Age classes	CSMON-LIFE volunteers	Italian population	CSMON-LIFE volunteers (%)	Italian population (%)
0 - 4	0	2141686	0	3.63
5 - 9	18	2521156	1.31	4.27
10 - 14	249	2813825	18.15	4.77
15 - 19	170	2863585	12.39	4.85
20 - 24	131	2959509	9.55	5.02
25 - 29	98	3028159	7.14	5.13
30 - 34	70	3216468	5.1	5.45
35 - 39	112	3409906	8.16	5.78
40 - 44	148	3862299	10.79	6.55
45 - 49	121	4594332	8.82	7.79
50 - 54	96	4783925	7	8.11
55 - 59	72	4707156	5.25	7.98
60 - 64	56	4034757	4.08	6.84
65 - 69	16	3518007	1.17	5.96
70 - 74	11	3370778	0.8	5.71
75 - 79	3	2649157	0.22	4.49

80 - 84	1	2280682	0.07	3.87
85 - 89	0	1400174	0	2.37
90 - 94	0	643298	0	1.09
95 - 99	0	164104	0	0.28
100	0	20159	0	0.03

Normality tests for the distribution of volunteers in age classes during CSMON-LIFE was carried out by mean of the Shapiro-Wilk normality test (R stats package); normality test for the distribution in age classes for the Italian population was carried out by mean of the Anderson-Darling normality Test (R nortest package, Gross et al., 2015), since the population exceeds 5000 units. The comparison between the distribution per age classes of the citizen scientists and the overall Italian population was made by the Kolmogorov-Smirnov test (R stats package).

RESULTS

The distribution of participants per age classes in the project CSMON-LIFE is reported in table 1. The relevant amount of young participants (age classes 5-9, 10-14, and 15-19) is mostly due to the involvement of schools in CSMON-LIFE school contests, and almost all of them were retained for a very limited amount of time only (see Martellos et al., 2021). The distribution in other age classes has a maximum in the class 40-44, with the older participant in the age class 80-84. An evident drop in volunteers number is evident from age class 65-69.

The distribution of volunteers in age classes is not normal (Shapiro-Wilk test $W = 0.93575$, p-value $< 2.2e-16$), as well as the distribution of Italian population (Anderson-Darling test $A = 298956$, p-value $< 2.2e-16$). Thus, for comparing the two distributions a non parametric test was used. According to the Kolmogorov-Smirnov Test ($D = 0.28808$, p-value $< 2.2e-16$) the distribution of volunteers in age classes is significantly different from that of the overall Italian population. Even if the bias due to the involvement of schools in the CSMON-LIFE project is discarded, taking into account the age classes starting from 20-24, results do not change (both distributions are not normal, $W = 0.97205$, p-value $= 2.026e-12$ and $A = 249718$, p-value $< 2.2e-16$, and are significantly different, $D = 0.27901$, p-value $< 2.2e-16$). Therefore, the different distribution in age classes between CMON-LIFE volunteers and Italian population is mostly due to the different percentage in older age classes (Figure 1). The percentage of volunteers in CSMON-LIFE for age classes >55 is far lower than that of the Italian population, and decreases practically to 0 for age classes >75. The maximum is reached in the age class 40-44 for CSMON-LIFE, while it is in the age class 50-54 for the Italian population. At the same time, the percentage for Italian population never drops below 1% till the age class 95-99 (Table 1).

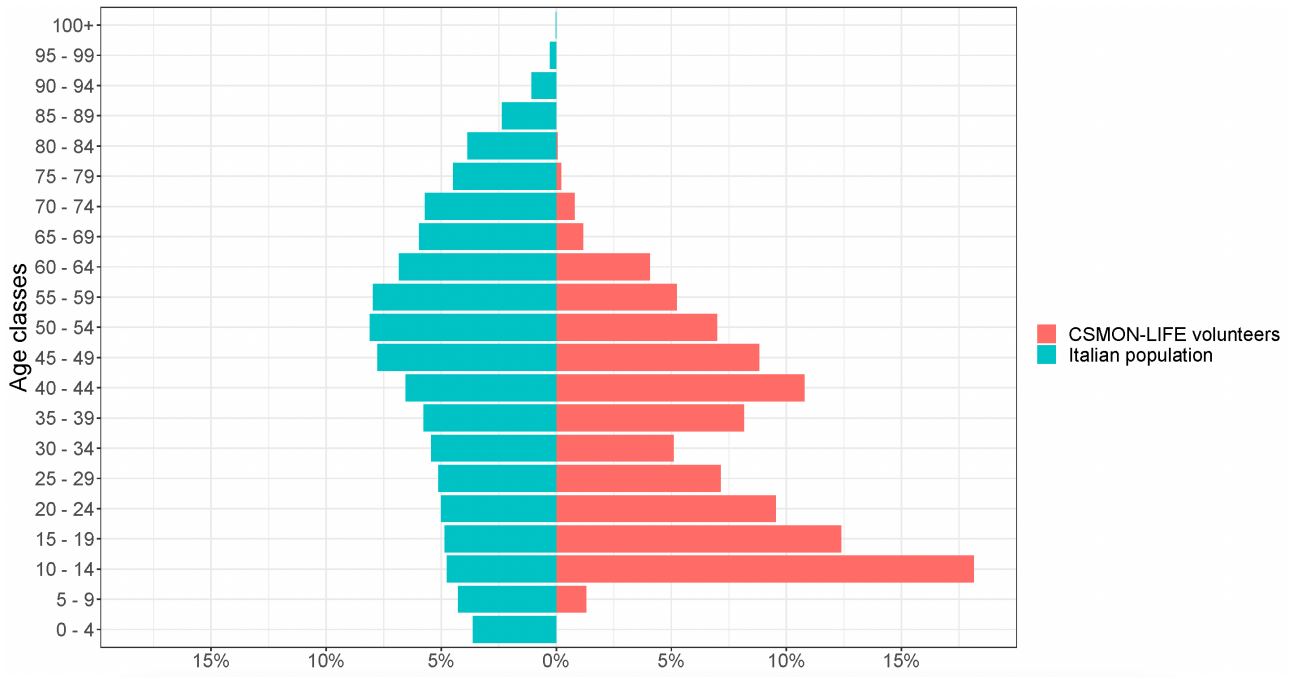

Figure 1. Percentage distribution of CSMON-LIFE volunteers and Italian population in age classes.

As far as the platform adopted by volunteers for submitting their observations (Table 2), the WebApp is adopted by only a small fraction of users in comparison with the Apps for mobile devices. Android is the most widely adopted mobile Operating System (OS) in all age classes, while iOS devices are adopted by ca 35% of the volunteers in each age class, but in the older one, which however counts a limited amount of participants (24).

Table 2. Platform adopted for submitting observations per age class.

Year of birth	App - Android OS	App - iOS	WebApp
<=1950	22 (78,57)	5 (17,86)	1 (3,57)
1951-60	76 (66,09)	36 (31,3)	3 (2,61)
1961-70	129 (63,24)	65 (31,86)	10 (4,9)
1971-80	176 (65,92)	87 (32,58)	4 (1,5)
1981-90	107 (64,46)	50 (30,12)	9 (5,42)
1991-00	169 (62,36)	99 (36,53)	3 (1,11)
2000-08	215 (66,77)	101 (31,37)	6 (1,86)
TOT	894 (65,11)	443 (32,27)	36 (2,62)

DISCUSSION

CSMON-LIFE (LIFE13 ENV/IT/832) is a project funded by the EU Commission in the framework of the LIFE+ programme in the period 2014-2017. CSMON-LIFE aimed at involving volunteers in the observation of several target organisms, as indicators of some environmental feature, such as stresses deriving from global change, or the presence of rare or endangered species, etc. CSMON-LIFE did not engaged specific groups, but aimed at a wide involvement in all age classes, as well as in any level of education. Volunteers were provided only with a slight training, mostly by mean of simple instructions in the use of the App or WebApp for submitting observations to the project. For each target organism, a detailed fact sheet was available in the Web portal of CSMON-LIFE and in the App. A little training was provided to school children only in the framework of the project's contests. In Martellos et al. (2021) it is evidenced how recruitment was achieved, and the retention rate during and after the project, in the so-called after-LIFE phase. Apart from schools, which were contacted directly in the intervention area of the project (Lazio and Puglia Regions, even if also other schools were allowed to participate as well), all other volunteers were recruited thanks to awareness raising activities, ranging from public presentations to the participation to television shows. In order to allow for the widest participation, observations could be submitted not only by mean of App for mobile devices (both Android OS and iOS), but also by mean of a simple WebApp, which was accessible on the Web Portal of the project. This allowed contribution also from volunteers equipped with mobile devices with other OSs (during the project, Microsoft Windows Mobile and BlackBerry OSs - currently discontinued - had a limited market share). Plus, to further facilitate the activity of volunteers, CSMON-LIFE allowed volunteers to send observations by mean of other digital channels (e.g. by email). However, it was not possible to submit observations in any analogical format. Since the beginning, this was evidenced as a potential barrier for the involvement of volunteers, especially for old adults.

In the case of CSMON-LIFE, older age classes are under-represented, if compared to the overall Italian population. While the age class >=65 makes up the is 23,8% of the total Italian population, the percentage of volunteers of this class is only 2,26%, about ten times less. On the contrary, younger age classes (< than 46, excluding the class 0-5, which was not involved in CSMON-LIFE) makes up for the 41,82 of the Italian population, and 72,59% of the volunteers of CSMON-LIFE. These differences cannot be safely ascribed to one factor alone. However, it is can be hypothesized that a relevant contribution to these differences, and especially to the limited participation of old adults, could be due to the adoption of digital only platforms for participation. Citizens belonging to older age classes, even if trained to the use of mobile devices, are not natively digital, and therefore they may often face several issues while using mobile devices other than for phone calls. Thus, they could be less involved in initiatives which make large use of Apps or digital platforms in general.

Apps were however adopted by a large majority of participants, even in the old age classes. The WebApp, which was specifically developed in order to involve the volunteers which were less used to work with mobile devices, was used only by a minor part of volunteers (Table 2). The Android App was adopted by ca. 65% of users overall, with a maximum in the oldest age class. On the contrary, the iOS App was used by ca. 32% of users, with a minimum in the modest age class. Several sources (StatCounter, https://gs.statcounter.com/vendor-market-share/mobile/italy; Counterpoint, https://www.counterpointresearch.com/global-smartphone-share; International Data Corporation, IDC, https://www.idc.com/promo/smartphone-market-share/vendor) report that the market share of iOS devices ranges between 11 and 21% in the last 5 years in Italy, as well as worldwide. Thus, a slight more than 30% of volunteers using iOS

devices could suggest two possible scenarios: a) iOS devices, being more expensive, are chosen by persons which have well-paid jobs, deriving from higher education, and are consequently more curious and interested in science and research, or b) iOS devices, because of their cost, or because of a longer product life, have a lower turnover rate than other devices, and thus the market share does not match with the actual number of volunteers equipped with iOS devices.

In conclusion, it is safe to assume that digital divide could have a negative effect on the participation of volunteers from the old adult age classes, even if, when engaged, they are normally retained for longer periods (Martellos et al., 2021). This effect will probably slowly disappear as soon as natively digital citizens will increase in number. However, any citizen science initiative which aims at involving old adults should take into account this issue, and consequently properly address its target groups.

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