Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Research Article

Sea swimming and snorkeling in tropical coastal blue spaces and mental well-being: Findings from Indonesian island communities during the COVID-19 pandemic

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ABSTRACT

The COVID-19 pandemic has considerable mental health impacts. Immersive nature-based interventions, such as swimming or snorkeling, may help mitigate the global mental health crisis caused by the pandemic. To investigate this, we collected cross-sectional data from residents of coastal villages (n = 308) in Kepulauan Selayar, Indonesia. Analysis of Covariance (ANCOVA) was used with mental well-being as the outcome variable, operationalized as the Mental Component Summary (MCS) scores from the SF-12 (12-item Short Form Health Survey). After adjusting for covariates, the activity of sea swimming or snorkeling was found to be significantly associated with better mental well-being ($\eta^2 = 0.036$; $p < 0.01$). Predictive margins analysis revealed that those who engaged in sea swimming or snorkeling for one to three days a week gained a 2.7 increase in their MCS scores, compared to those who did not. A non-linear dose-response relationship was detected: for those swimming or snorkeling more than three days per week, there was only an increase of 1.7 MCS score compared to the 0-day. Overall this study contributes to the expanding of evidence base, showing that interactions with blue spaces can be beneficial for mental health, especially in a potentially stressful time such as the current pandemic. *Management implications:* The positive association between the activity of swimming or snorkeling in open seas and the mental well-being of rural coastal communities in Indonesia during the COVID-19 pandemic indicates that access to coastal blue spaces is important in a time of uncertainties and high stress. Ensuring that local communities have continuous access to these spaces is the key challenge for all relevant stakeholders, particularly in light of the growing privatization of the local coastal environment for the sake of tourism. However, considering the importance that these blue spaces hold for the mental well-being of local communities, intensive dialogue amongst these stakeholders must be pursued to ensure that the development of the area does not jeopardize the collective well-being of the people already living there.

1. Introduction

1.1. COVID-19 and mental health problems

As of September 2022, the COVID-19 pandemic has infected more than 613 million people worldwide with a case fatality rate of around 1.1% (World Health Organization, 2022), equivalent to the country of Denmark losing its entire population (United Nations Population Fund, 2022). Yet, the inequalities existing globally and within countries are likely to cause an uneven distribution of the impacts of the COVID-19 pandemic, which, in turn, may exacerbate existing inequalities (Blundell, Costa Dias, Joyce, & Xu, 2020). This feedback loop of pandemic and inequalities is particularly salient for those living in the Global South (Hamadani et al., 2020; Stewart, El-Harakeh, & Cherian, 2020), with

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increased economic vulnerabilities for those living in rural areas (Ranscombe, 2020). In Indonesia, the pandemic has been projected to result in an increase of 19.7 million people living in poverty (Suryahadi, al Izzati, & Suryadarma, 2020), many of whom are likely to be living in rural areas (World Bank, 2020). Furthermore, the expected long-term difficulties in delivering access to COVID-19 vaccines in many of the countries in the Global South may further worsen the likely-to-be persistent impacts of the pandemic in the future (Figueroa et al., 2021).

The impacts of the COVID-19 pandemic, however, extend beyond the direct economic and physical health dimensions. Recent systematic reviews and meta-analyses of cross-sectional studies performed during the pandemic have revealed considerable increases in the prevalence of mental health problems (i.e. depression, anxiety, insomnia, distress, and post-traumatic stress disorder) globally (Bueno-Notivol et al., 2021; Cénat et al., 2021; Wu et al., 2021). This deterioration in mental well-being is potentially caused both by the characteristics of the COVID-19 pandemic itself and by the measures taken to protect the population (Dubey et al., 2020; Holmes et al., 2020). The strict stay-at-home orders and social distancing mandates, issued and enforced before, during, and after the vaccination drives in many countries, have limited opportunities for wider social interactions and potentially intensified interpersonal conflicts within households (Gruber et al., 2021). Moreover, the high risk of infection and the potential long-term impacts and existence of the disease have been linked to increased feelings of threat and uncertainty in individuals (Rettie & Daniels, 2021).

1.2. The importance of contact with nature for mental well-being during the pandemic

Considering the long-term burden on mental well-being caused by the COVID-19 pandemic, research has explored potential everyday interventions to mitigate mental health risks in the face of future uncertainties (Holmes et al., 2020; Rajkumar, 2020). The last two decades have seen increasing research focused on the role of nature and increased contact with natural spaces, with a number of systematic reviews highlighting the positive impact of natural outdoor environments and mental health (Gascon et al., 2015, 2017; Thomsen, Powell, & Monz, 2018). However, the majority of existing studies have focused on terrestrial green spaces, such as urban parks and forests, thus overlooking blue spaces (White, Elliott, Gascon, Roberts, & Fleming, 2020), areas characterized by substantial presences of inland and coastal waters (Bell, Phoenix, Lovell, & Wheeler, 2015; McDougall, Quilliam, Hanley, & Oliver, 2020). Examining 35 papers, the systematic review by Gascon, Zijlema, Vert, White, and Nieuwenhuijsen (2017) found an association between better mental well-being and exposures to blue spaces. However, more recent research has found an inconsistent relationship between well-being and blue spaces (Boers, Hagoort, Scheepers, & Helbich, 2018; Garrett, Clitherow, White, Wheeler, & Fleming, 2019; Hooyberg et al., 2020; Vert et al., 2020).

These divergent findings may be linked to the use of residential proximity to blue spaces as the main exposure metric (Crouse et al., 2018). It has been argued that proximity to natural spaces in itself may not be sufficient to generate mental health benefits (White et al., 2021). Instead, research needs to consider 'intentional use of' or 'immersive engagement', such as walking by or swimming in the sea, as potentially better predictors of good mental well-being (Bielinis, Takayama, Boiko, Omelan, & Bielinis, 2018; Gidlow et al., 2016; Koselka et al., 2019; White et al., 2021).

Immersion in nature itself has been theorized to have beneficial mental health impacts due to the inherent emotional affiliation of humans to nature (Nieuwenhuijsen, Khreis, Triguero-Mas, Gascon, & Dadvand, 2017), which can be exploited to promote and maintain human health and well-being as the ultimate form of ecosystem service from the natural world (Sandifer, Sutton-Grier, & Ward, 2015). Within this context, the therapeutic potential of immersion in nature has been increasingly prescribed by medical practitioners for certain mental health disorders (Wessel, 2017; Zarr, Cottrell, & Merrill, 2017). A recent systematic review of blue space interventions based on immersive activities in blue spaces, which included swimming, found a positive association with health and well-being outcomes (Britton et al., 2018a). The activity of swimming in natural water bodies offers physical immersion that has been claimed to offer cognitive and healing benefits through its particular affective characteristics, intensely involving the emotional experiences of the swimmers (Foley, 2015; Merchant, 2011). Mental health benefits have been associated with sea swimming (Costello, McDermott, Patel, & Dare, 2019; Denton & Aranda, 2019), including its potential as a treatment for major depression (van Tulleken, Tipton, Massey, & Harper, 2018).

The pandemic has highlighted that the future is uncertain. In response, research needs to focus on the everyday activities that can help mitigate the impact of this uncertainty on mental health and well-being, particularly in the Global South. Such a focus on the Global South is important, as, to date, most studies examining the association between mental well-being and exposures to nature have been focused on populations in the Global North (Shuvo, Feng, Akaraci, & Astell-Burt, 2020). In other parts of the world, particularly within the context of low and middle-income countries (LMICs) in the Global South, these findings might not apply due to different social, economic, and cultural conditions (Rigolon, Browning, Lee, & Shin, 2018; Saw, Lim, & Carrasco, 2015). Indeed, outside the Global North, blue spaces can have a negative health connotation with increased risks, perceived or actual, of individual and communal threats (such as natural disasters) and illnesses (Collins & Kearns, 2017; Fleming, Praptiwi, Goh, & Raps, 2021). For instance in Indonesia, a nation of many low lying islands, natural disasters, including storms, tsunamis, and volcanic eruptions are both historic and realities of human-ocean interactions (Djalante & Garschagen, 2017; Marfai et al., 2008).

Within this context, this study explored if people who intentionally visited coastal blue spaces for recreational activities had better mental well-being in small island communities in Indonesia during the time of the pandemic. This study attempted to expand the evidence base regarding the potential benefits of interaction with blue spaces by focusing on communities living in a country in the Global South, where studies on the topic are still lacking. Individual outdoor recreational activities were still allowed by the devolved regional governments of the country, despite social restriction measures implemented after the declaration of the pandemic by the World Health Organization (Roziqin, Mas'udi, & Sihidi, 2021). In terms of immersive recreational activities in coastal areas, such as swimming and snorkeling, quantitative and qualitative studies in Indonesia have demonstrated that these are traditionally popular pastime activities across age and gender groups and widely performed in various islands in the country both by tourists and local people (Mutmainah, Kusumah, Altanto, & Ondara, 2016; Putri, Sutadji, & Susanto, 2019; Rahimah, Rosmasita, Yanti, & Fani, 2020). More specifically, in the context of our case study site, Sulawesi Island, various cultural practices incorporate direct contact with sea water in traditional localized forms of recreation, such as swimming excursions or water-based games with wide-ranging participation across community members (Tatali, Lasabuda, Andaki, & Lagarense, 2018; Theodorus, 2021; Yulius & Arifin, 2014). Thus, according to the aforementioned considerations, we hypothesized that engaging in recreational sea swimming or snorkeling would be associated with better mental well-being outcomes compared to the less immersive activity of recreation on the shoreline or beach. By disaggregating the recreational activities based on their immersiveness, the knowledge gathered in this study provides unique insights that would be potentially beneficial in terms of designing mental health interventions for the local populace and the management of coastal and marine environment in the studied area and, more generally, the region.

2. Method

2.1. Study location and population

The study was performed inside the Taka Bonerate Kepulauan Selayar (TBKS) UNESCO Biosphere Reserve, South Sulawesi, Indonesia. The Biosphere Reserve was selected for this study due to it being situated in a marine area known to be a tropical marine biodiversity hotspot (Hoeksema, 2007). The specific location consisted of the four small islands of Selayar, Bahuluang, Tambolongan, and Polassi, situated in the transition zone, outside the protected Biosphere Reserve core area (Fig. 1). The survey performed in this study targeted households in the villages collectively governed under the administrative District of Bontosikuyu.

The District was purposively selected for the study as it had the highest number of people working as fishers in the Biosphere Reserve (Ngadi, 2017), thus potentially having more frequent habitual interactions with the coastal and marine ecosystems in the area. These small-scale fishers are mainly reliant on the surrounding coral reef ecosystems as their fishing grounds (Krueck et al., 2019). The total population of the study site is 15,303 people, with an annual demographic growth rate of 0.64% (BPS Kepulauan Selayar Regency, 2021). The surveyed area has been characterized as rural and isolated from the regional commodity markets (Lindsay et al., 2020); and served by only one hospital and 14 health centers, dispersed throughout the area, with inadequate facilities and staff (Herianto & Syaharuddin, 2020).

Official data on the number of COVID-19 cases recorded in the Biosphere Reserve are not publicly available. However, a recent news article, citing a source from the local COVID-19 Response Acceleration Taskforce, reported that, as of July 2021, there had been 650 confirmed cases from a total population of about 135,000 people, including 24

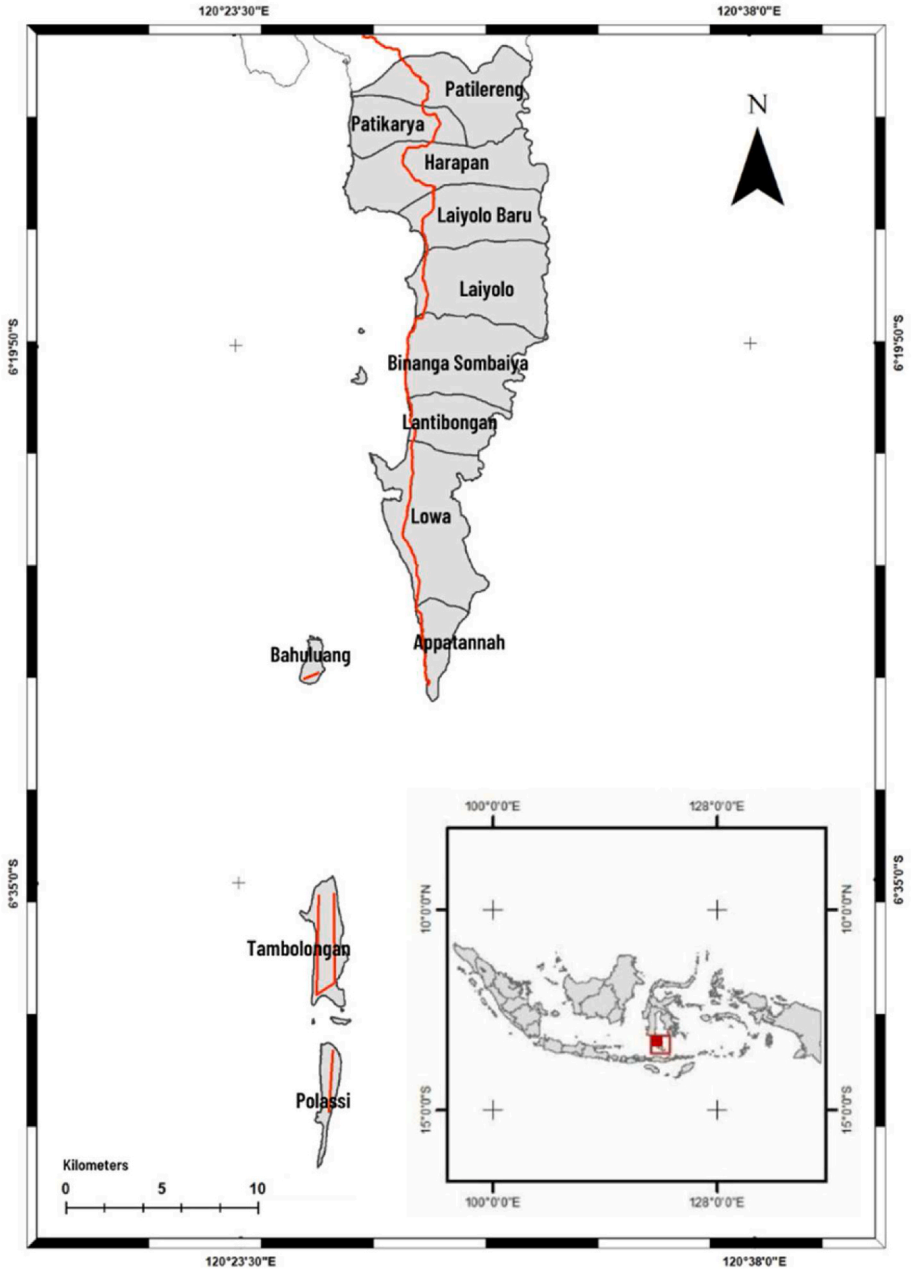

Fig. 1. Map of the survey area, shaded in grey, and the main road (red line) taken by survey interviewers on the main island (Selayar), and the surrounding small islands, with the inset showing its location in Indonesia (the red dot inside the redbox delineating the Taka Bonerate Kepulauan Selayar Biosphere Reserve).

deaths in the Biosphere Reserve (Selayarnews, 2021). The area itself has never been quarantined or subjected to strict lockdown. Instead, the devolved regional government was given the autonomy to implement a less strict form of social mobility and interaction restriction measures, including the closure of local schools and markets, than those applied in the more densely populated areas of Indonesia (Mubarok & Rusyiana, 2021). These regional measures were gradually relaxed from 2020 to 2021 and still allowed for both movements of individuals across villages and islands, and individual recreational activities (Padli & Rusdi, 2020). This context enabled both the local people to carry out recreational activities surveyed in this study and the study itself to be conducted through face-to-face interviews.

However, despite the less stringent measures, the direct socio-economic impacts of the pandemic are likely to be substantial. In the middle of the first phase of the regional social restriction measures (May 2020), the capture fisheries in the region saw a 75.5% decline in production compared to the same month in the previous year (Regional Office for Marine Affairs and Fisheries, 2021), whilst tourists visiting the area in 2020 declined to almost a tenth of the preceding year (Selayar Tourism & Culture Office, 2021). These factors were indicative of a substantial loss of income sources, demonstrated to be significant sources of stress (Bonanno, Galea, Bucciarelli, & Vlahov, 2007).

2.2. Survey structure, distribution, and procedure

The survey was developed as one part of the Blue Communities research program (https://blue-communities.org), specifically created to understand the risks and benefits of coastal living to the health and well-being of communities of Marine Parks and Marine Protected Areas in four Southeast Asian countries (Indonesia, the Philippines, Malaysia, and Vietnam). The initial survey was developed through a series of co-creation processes with local stakeholders in the Philippines. The full details of survey development and structure are described in Madarcos et al. (2021).

To explore the applicability of the survey to the Indonesian context, the survey was first piloted on Selayar Island (Fig. 1), in June 2019. The piloting involved 10 members of local coastal communities in Bontosungu, Parak, and Apatannah villages. Based on the experiences gained from the process, some wording and order of the survey sections were rearranged to facilitate better comprehension (Supplementary Material 1). For the current study, only three sections were used: Section 1 (socio-demographic data), Section 2 (interactions with the local marine environment), and a key item from Section 3 on health, the SF-12 (12-item Short-Form Health Survey). The modified survey received ethical approval from the Research Ethics Committees in Universitas Esa Unggul (0563-19-525/DPKE-KEP/FINAL-EA/UEU/XII/2019) and the University of Exeter Medical School Research Ethics Committee (RG/CB/19/06/214).

The survey for this study was conducted face-to-face, with the interviewers and the interviewees observing local health protocols published by the Indonesian Government (The Indonesian Ministry of Health, 2020). Additional ethical approval for data collection during the COVID-19 pandemic was obtained from the Research Ethics Committees in Universitas Nasional (03/DKEP/UNAS/X/2020) and University of Exeter Medical School (RESTART approval for RG/CB/19/06/214), after ensuring that the research protocol was modified to include specific procedural health protection measures as outlined in the Indonesian Government health protocol guidelines (e.g. physical distancing, the wearing of face masks and/or shields, and the use of antigen tests before and after fieldwork for the interviewers).

Data collection was performed by six local survey interviewers, all of whom are residents of Selayar Island, after the first phase of the regional pandemic social restriction measures was terminated by the local government in late October 2020. The coordination workshop and training sessions for the interviewers, who were already experienced in conducting surveys for the local Fisheries and Marine Affairs Agency, took place online before data gathering. The in-person interviews were conducted for the first few coastal villages in the last week of October 2020, with the last one surveyed on the November 10, 2020.

The survey covered eleven coastal villages located in the Bontosikuyu District, a region for which any publicly available address registries did not exist. As such, the survey interviewers, after obtaining approval from the village leaders, chose a household randomly and proceeded to interview only one member, aged at least 18 years old, per household. Purposive sampling was used within households to ensure a heterogeneous sample, in terms of gender. A participant information sheet, with an informed consent form, was given to each respondent explaining both the background of the study, the anonymity of their participation, and the right for each participant to withdraw at any point of the interview. Irrespective of whether a respondent withdrew from or completed the survey, the interviewers moved to the subsequent randomly selected household. On each island, all of the houses and the villages tend to be located along a main road or pathway that runs parallel to the coastlines from north to south (Fig. 1). All the participants of this study consisted of local community members, instead of tourists or visitors to the area, with 308 villagers participating in the survey (Supplementary Material 2).

2.3. Response variables

In this study, mental well-being was operationalized as the Mental Component Summary (MCS) scores of the 12-item Short Form Health Survey (SF-12) version 2 completed by the participants of the survey. The SF-12 was developed from the 36-item Short-Form Health Survey (SF-36) (Ware, Kosinski, & Keller, 1996) and assessed the physical and mental status of respondents (Ware, 2000). The SF-12 is based on a standard recall of four weeks and takes around 2 min to complete (Ware, 2021). It has been demonstrated to have a high construct validity when used to detect differences in mental conditions (Ware et al., 1996). In Indonesia, the SF-12 has recently been validated for studying the quality of life of middle-aged and older adults in the Indonesian population (Arovah & Heesch, 2021), with good psychometric properties of the MCS for the population, as indicated by an internal consistency (Cronbach's alpha) of 0.79 and a 1-week test-retest correlation of 0.75, comparable with the original US version (Ware et al., 1996). The MCS scores were obtained from six items, rated on a five-point Likert scale, of four subscales measuring vitality, mental health, emotional problems, and social functioning, with higher scores indicative of better mental health and functional status (Ware et al., 1996).

2.4. Predictors: blue spaces recreational activities

Recreational activities in blue spaces measured in this study are defined as the intentional exposures of visiting blue spaces to perform leisure activities (White et al., 2020). We were particularly interested in the recreational activities of sea swimming or snorkeling, and going to the shoreline for recreation. Responses were gained through a self-reported method by asking the study participants to fill the items in Section 2 of the survey (Supplementary Material 1), which included marine interactions relating to livelihoods, day-to-day activities, and environmental management. Participants were asked to estimate the number of days in the preceding week that they engaged in various types of activities. Responses were recorded on an eight-point scale ranging from the anchor points of zero (0) to seven (7) days. For this study, only the following items were used: the recreational activity of swimming or snorkeling, and the recreational activity of going to the shoreline to play or for other recreational activities. Furthermore, we re-coded the number of days per week each activity was engaged in into categorical variables of 0-days, 1–3 days, and >3 days, to increase statistical power (Lipsey & Hurley, 2009; Meyvis & van Osselaer, 2017).

2.5. Control variables

We controlled for socioeconomic and demographic factors that are known as potential confounders when analyzing the association between blue spaces and mental health outcomes. Six potential covariates were selected based on existing literature, emphasizing studies performed in areas that shared a degree of similar cultural and/or geographical/environmental contexts with this study (Chen & Yuan, 2020; Garrett, White, et al., 2019; Huang et al., 2019; Kim & Kim, 2017). The control variables consisted of: gender (female = ref; male); age (continuous variable); educational level (no education = ref;; elementary, junior high school, high school, college); social security status (no social security = ref; National Health Insurance, private health insurance); and monthly household income (continuous variable). Because a given income means different things for different household sizes, we used data on household composition to construct an 'equivalised' income variable (i.e. accounting for the number of adults and children) as our final measure of household deprivation, as recommended by Garrett, White, et al. (2019) and using the protocol outlined by Eurostat (2021).

2.6. Statistical analysis

Descriptive statistics, expressing continuous variables as means with standard deviation (SD) and categorical variables as relative percentages, were used to summarise the sample dataset. Boxplots, bar charts, and pie charts were also generated to illustrate the distribution and the relationship between the number of days per week, categorized into three groups (0 days, 1–3 days, and >3 days), spent for the recreational activities of interest, and the variables of MCS scores, age, educational level, monthly household equivalised income, and gender.

Analysis of Covariance (ANCOVA) was used to test whether engaging in recreational sea swimming or snorkeling would be associated with better mental well-being outcomes compared to the less immersive activity of recreation on the shoreline or beach, with the continuous outcome being the MCS scores. ANCOVA was used as the study was not experimental that socio-demographic variables had to be included in the statistical analysis to control for the inherent differences in the study participants, particularly on the account of potential self-selection bias to the recreational activities being measured. The baseline model (M1) included our two main predictors of immersive activities, i.e. swimming and snorkeling, and walking along the shoreline. A forward selection procedure was applied to include potential covariates into the model. Log transformation was performed for the covariate of the equivalised monthly household income due to its skewed distribution. The Akaike Information Criterion (AIC) was used to evaluate the balance between model fit and complexity and to arrive at the most parsimonious model, with the main model (M2) having the lowest value of AIC possible, after adjusting for covariates. The F-statistic was used to test significance, using the two-tailed alpha value of 0.05.

Multicollinearity was analyzed by estimating the Variance Inflation Factor (VIF) in the main model. The largest VIF in the main model was 1.57, below the threshold value of 3 (Zuur, Ieno, & Elphick, 2009), indicating the absence of substantial multicollinearity among the independent variables. The aforementioned statistical analyses were performed using Stata 17.0. In addition, a post-hoc statistical power analysis was performed using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007).

3. Results

3.1. Participant characteristics

The descriptive statistics of the sample dataset are displayed in Table 1. Of the 308 participants surveyed, 37.7% were females and 62.3% were males, with the majority having at least a junior high school degree or above (82.5%) and national health insurance (80.8%). Regarding recreational activities undertaken in the preceding week, 67.9% did not swim or snorkel at all and 53.11% did not go to the shoreline for recreation. The mean MCS score was 56.86 (±5.28), whilst the mean age was 42.2 years. The equivalised income had a mean value of IDR (Indonesian Rupiahs) 718,060.6 (±788,496.1), which was only 1.5 times higher than the Indonesian poverty line of having a monthly income of IDR 472,525 per capita (Badan Pusat Statistik, 2021).

Table 1
Descriptive profiles of the survey participants (n = 308).

Variables	Mean (SD)/Percentage (N)
Outcome Variable	
Mental component summary (MCS) score of SF-12	56.86 (5.28)
Predictors	
Recreational swimming or snorkeling (%)	
0 days	67.9 (207)
1–3 days	25.9 (79)
> 3 days	6.2 (19)
Recreation on the shoreline (%)	
0 days	53.1 (162)
1–3 days	26.2 (80)
> 3 days	20.7 (63)
Control Variables	
Gender (%)	
Female	37.7 (116)
Male	62.3 (192)
Education (%)	
No education	14.6 (45)
Elementary school	2.9 (9)
Junior high school	36.4 (112)
Senior high school	39 (120)
College/University	7.1 (22)
Social Security Status (%)	
No health insurance	7.8
National health insurance	80.9
Private health insurance	11.4
Age	42.2 (12.34)
Equivalised Monthly Household income (IDR)	718,060.6 (788,496.1)

The boxplots of Fig. 2 indicate that the median MCS scores for those who performed sea swimming or snorkeling for at least a day were higher than those who did not. As for the activity of recreation on the shoreline, the median MCS scores did not greatly differ between groups. Fig. 2 also displayed the socio-economic characteristics of those who engaged in recreational activities. In terms of age, those who spent one to three days per week for recreation on the shoreline had a lower median age, slightly larger median equivalised monthly household income, and higher median education level compared to those who spent more than three days or did not perform this activity at all. As for those who performed sea swimming or snorkeling for one to three days per week, they had a higher median education level (senior high school) and larger median equivalised income compared to those who did not swim or snorkel at all or who swam or snorkel for more than three days. There were, however, no discernible differences in terms of median age for those who swam or snorkeled and did not. With regards to gender, Fig. 3 indicated that both the surveyed male and female respondents had relatively similar rates of engagement or non-engagement in either the activity of shoreline recreation or sea swimming or snorkeling over the preceding week.

3.2. Mental well-being and intentional recreational exposures to coastal blue spaces

Table 2 displays the results of ANCOVA models, comparing unadjusted Model 1 with Model 2, the most parsimoniously adjusted model with covariates based on the estimated AIC values. The model which adjusted for all control variables is available in Supplementary Material 3. Significant associations ($p < 0.01$) with MCS scores were observed for the main predictor of recreational swimming or snorkeling (effect size =

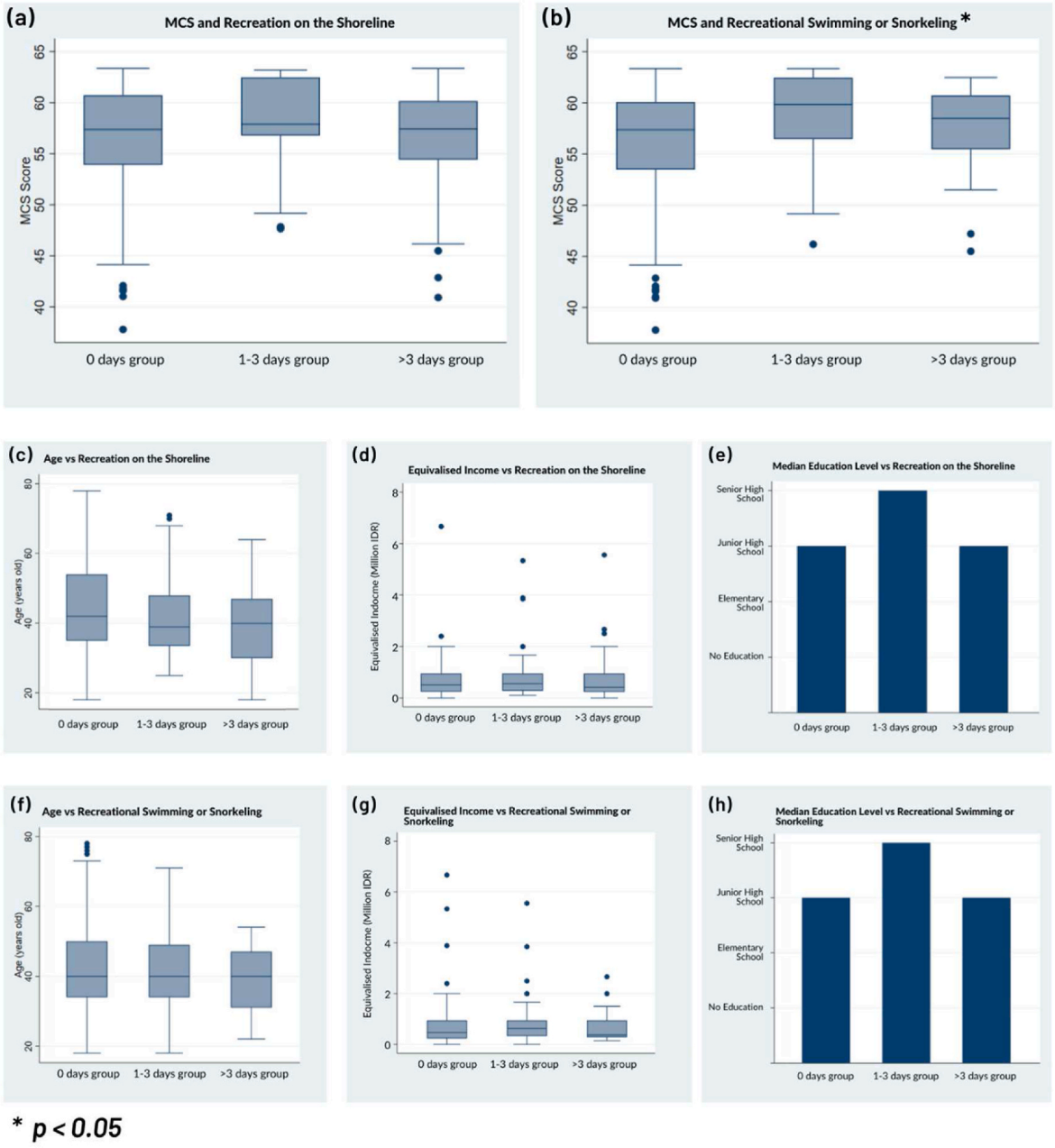

Fig. 2. Graphical representation of the composition of recreational swimmers/snorkellers and those who engaged in recreation only on the shoreline, in terms of MCS scores (a and b), age (c and f), equivalised income (d and g), and education level (e and h).

0.04) and equivalised income (effect size = 0.02), with a smaller but significant association with age (effect size = 0.02; $p < 0.05$). In both models, recreational swimming or snorkeling was consistently found to be highly significant for mental well-being. The effect sizes of recreational swimming or snorkeling lie between the threshold suggested by Miles and Shevlin (2001), with low effect sizes classified as eta squared (η^2) value below 0.01 and medium effect size around 0.06. Post-hoc analysis of the statistical power of the observed effect size for swimming produced a value of $1\text{-}\beta = 0.71$.

Using predictive linear margins analysis based on Model 2, Table 3 indicates that if all independent variables are held constants, the MCS for individuals engaging in swimming or snorkeling for at least 1–3 days was 2.7 points higher compared to those who did not swim or snorkel at all. However, increasing the frequency of sea swimming or snorkeling to more than three days would be associated with a decrease of this benefit by one point compared to the 1–3 days swimming or snorkeling group.

In terms of equivalised income, Fig. 4 showed that, all things held equal, having a lower income in a household would be associated with a decrease in the MCS scores, while the reverse is true for higher income although with much wider confidence intervals.

In more concrete terms, doubling the equivalised income above the poverty line of 427,525 IDR would be associated with an MCS score increase of 0.48 points. The same figure also reveals that the MCS benefit associated with a shift of swimming or snorkeling frequency from 0 days to 1–3 days per week is equivalent to about a 7.5-fold increase of equivalised monthly household income from the poverty line. As for the covariate of age, it was found that a 20-year increase in age would be associated with a decrease in the MCS score by 1.2 points.

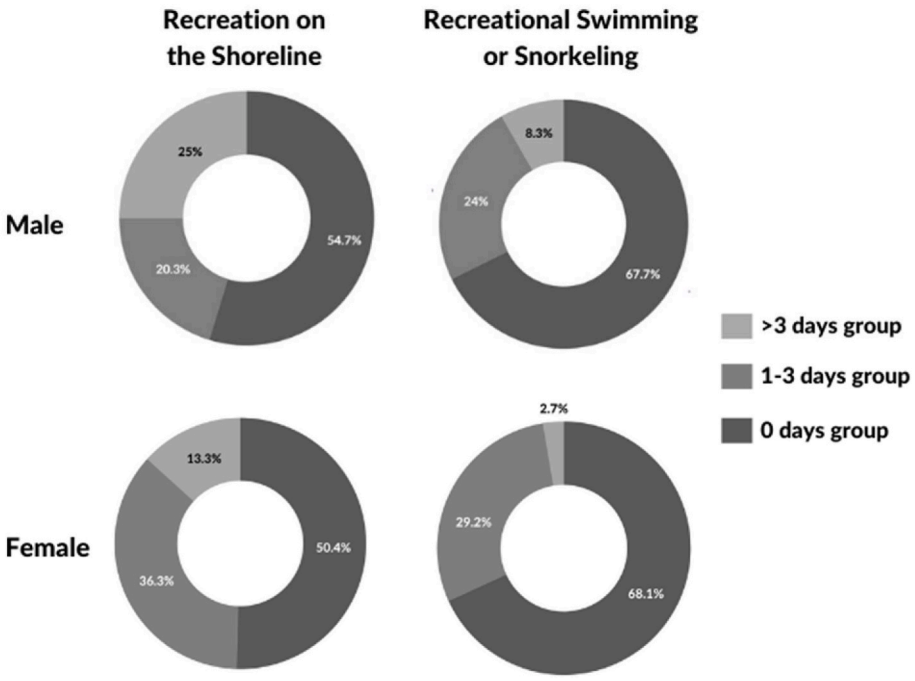

Fig. 3. The proportion of recreational swimmers and those who engaged in recreation on the shoreline for each frequency of activity group, according to gender grouping.

Table 2
ANCOVA results for MCS scores and recreational activities.

	M1[a]				M2[b]			
	Sum of Squares (SS)	F	p	Effect Size (Partial η^2)	Sum of Squares (SS)	F	p	Effect Size (Partial η^2)
Recreational swimming or snorkeling	294.63	5.54	0.0043	0.036	286.9	5.58	0.0042	0.036
Walking on the Shoreline	33.66	0.63	0.53	0.004	39.71	0.77	0.46	0.005
Equivalised monthly household income					185.74	7.23	0.0076	0.024
Age					159.51	6.21	0.01	0.02
Residuals[c]	8401.44				7553.5			

[a] ANCOVA with main predictors only (AIC = 1858.9).
[b] Adjusted ANCOVA with covariates (AIC = 1838.22).
[c] The unexplained variance in the model.

Table 3
Predictive margins of recreational swimming or snorkeling (n = 308).

	MCS Score Predicted Margins	Delta-method Std. Error	t	P>|t|	Lower 95% CI	Upper 95% CI
0 day per week	56.08	.38	147.3	0	55.33	56.83
1–3 days per week	58.78	.66	88.9	0	57.48	60.1
>3 days per week	57.81	1.29	44.75	0	55.27	60.35

4. Discussion

4.1. Sea swimming and snorkeling and mental well-being

Immersive activities in nature are increasingly promoted due to their associations with positive well-being benefits (Foley, 2017), including their use as a part of recovery or mental health therapy (Caddick, Smith, & Phoenix, 2014; Wheaton, Roy, & Olive, 2017). However, to date, much of the focus has been on immersive activities in green spaces in the Global North (Rigolon et al., 2018; Saw et al., 2015). Regarding the well-being benefits of immersive activities in blue spaces situated in a country from the Global South, our findings indicate a positive relationship between the activity of recreational swimming or snorkeling in the sea during the COVID-19 pandemic with better mental well-being among small-island communities in Indonesia.

We found that 32% of people living in coastal areas in a UNESCO Biosphere Reserve in Indonesia engaged in recreational swimming activities in the last seven days during the COVID-19 pandemic. These individuals had better mental well-being than those who did not swim, a result that was not found for recreational walking along the shoreline. Immersive blue space activities, such as swimming, have been associated with mental health benefits (Denton & Aranda, 2019; Foley, 2015, 2017). Open-water swimming or snorkeling practices may help individuals to cope during a period of heightened stress and uncertainty (Costello et al., 2019; Lloret et al., 2021). We also found a dose-response relationship where individuals who engaged in swimming or snorkeling for 1–3 days per week had 2.7 points higher better mental well-being compared to those who didn't swim or snorkel at all, and 0.97 points higher for those who swam or snorkeled for more than three days per week. Similar non-linear relationships have been found elsewhere (e.g. White et al., 2019; White et al., 2021), highlighting that the benefits of recreational exposure to blue spaces may decline after a certain

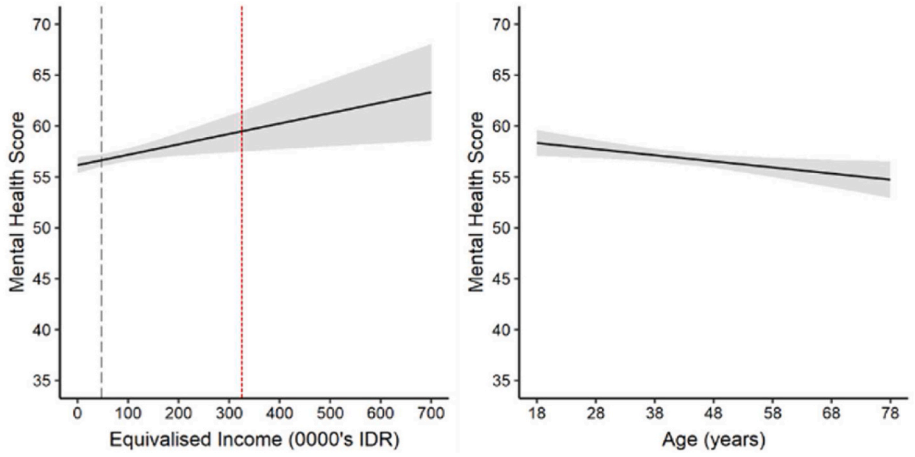

Fig. 4. Predictive margins plots for the covariates of equivalised monthly household income and age, generated from model 2 (M2) of the ANCOVA model, with the dashed vertical line indicating the poverty line, and the red dashed line showing the value of the increase of equivalised income from the poverty line that would yield the MCS score that is equivalent to the MCS benefit associated with a shift from 0 days to 1–3 days per week of wild swimming.

threshold of activity frequency is passed. Although the published literature is still lacking as to what constitutes an adequate dose and how it is produced (Frumkin et al., 2017), there is evidence indicating the presence of a non-linear relationship between dosage of nature and human mental health benefits in the context of the Global North (Fleischmann et al., 2011; White et al., 2019). Further research on the health outcomes of immersive blue space interactions is thus very much needed in the Global South.

It has to be noted that the physical characteristic of the coastal environment in our case study site differs from the majority of studies looking at immersive blue space interactions in the Global North. These studies examined the potential health benefits of activities performed in cold water bodies (for reviews see Tipton, Collier, Massey, Corbett, & Harper, 2017; Knechtle, Waśkiewicz, Sousa, Hill, & Nikolaidis, 2020), while the tropical location of our case study site ensures the year-round warm temperature of the water bodies used by the local people to swim or snorkel. Nonetheless, our results indicate that mental health benefits may still be associated with the activity of open water swimming regardless of the temperature of the water bodies.

In regard to the economic and demographic factors, the predictive margins analysis revealed that reduced equivalised monthly household income and increasing age were associated with lower mental well-being during the pandemic in our case study site. As has been observed by Sandifer et al. (2017), the loss of income brought about by an extreme event may lead to prolonged stress episodes for those impacted, as might be the case for some of our participants due to the pandemic. Our results regarding the covariate of age are directly counter to the findings obtained during the pandemic in European countries by Pouso et al. (2021), which indicated that older people had lower risks of common mental disorders. Our result can be potentially explained by the observations made by Lee and Lee (2019) and Huang et al. (2019) who showed that, for the elderly population, particularly in the Asian context, social activity is more important than physical activity for the maintenance of good mental health. The opportunities for social activity in our case study site, as was the case elsewhere, were limited by government-imposed restrictions during the pandemic, potentially rendering older adults at risk of having lower mental well-being.

However, it has to be noted that despite the potentially stressful situation brought about by the COVID-19 pandemic, the mean MCS score of our sample (56.85) indicates that the participants of this study were not at high risk for common mental disorders (Yu, Yan, & Chow, 2015). It has to be acknowledged that our study site is situated inside a tropical biodiversity hotspot (Hoeksema, 2007), designated as a UNESCO Biosphere Reserve. This biodiverse natural environment may be linked to positive mental well-being benefits (Rasheed, 2020).

Although further research works are still required to reveal how biodiversity influences mental health conditions (Depledge, Stone, & Bird, 2011; Lovell, Wheeler, Higgins, Irvine, & Depledge, 2014; Sutton-Grier & Sandifer, 2019), recent work by Cracknell, Pahl, White, and Depledge (2018) indicates that, in a more controlled context of a marine aquarium, more biodiverse exhibits are related to the reduction of stress. In addition, our respondents live in coastal villages with ample views of the sea, which, as indicated in a recent study of a residential urban setting in the Netherlands (Helbich et al., 2019), are associated with a lower risk of depression. In the specific context of our study site, these combined factors may be acting as a buffer for the local communities against the potential mental well-being harms that the pandemic may cause.

Despite our positive findings regarding the salutogenic effect of immersive interaction in tropical coastal blue spaces, it is important to highlight that barriers may exist that can prevent people from partaking in the activity of sea swimming or snorkeling. These may include lack of mobility, lack of access, a general feeling of fear, perceived bad quality of the water, and inability to swim (Doi, Katano, Negishi, Sanada, & Kayaba, 2013; Erickson, Johnson, & Kivel, 2009; Finlay, Franke, McKay, & Sims-Gould, 2015; Soga & Gaston, 2016), all of which may be associated with lower mental health scores in themselves. Furthermore, ensuring future accessibility of blue spaces for the local communities in our case study site is of the utmost importance, particularly in light of our positive findings.

The emergence of private marine protected areas related to tourism development that restricts the use of the water by the local population (Praptiwi et al., 2021) is threatening the flow of well-being benefits that may arise from interactions in the local coastal environment. Local stakeholders must thus engage in intensive dialogue to ensure that the vital blue spaces in these areas remain accessible to the coastal communities. This is crucial not only given our findings but because the relationship between natural outdoor environments with life satisfaction is very much enhanced by the ease of access to these areas (Methorst et al., 2021).

4.2. *Limitations and future studies*

Despite the positive findings of this study, the self-reported data on recreational activities were not validated with actual people's experiences, and, instead, relied on participant recall of their activities in the preceding week, which has nonetheless been used in prior research and reflects more accurate recall than longer periods such as a month or a

year (White et al., 2019). Furthermore, the cross-sectional nature of the study does not allow for any causal inferences to be made, including the direction of causality, and did not allow for inferences to be made regarding whether similar findings would emerge before the pandemic, or whether the cessation of much of the economic activities of the local people during the social restriction measures implementation can be linked to more frequent time being allocated to engage in sea swimming or snorkeling.

Nonetheless, our study contributes to the limited evidence base regarding the links between mental health and blue spaces, and we recommend further studies to ascertain whether the positive impact of sea swimming or snorkeling on mental well-being observed in this study is generalizable to other contexts. One of the potential avenues to be pursued is the analysis of the pathways linking this immersive recreational activity in blue spaces to mental well-being, an aspect that has been overlooked in previous similar studies (Dzhambov et al., 2018). Moreover, longitudinal research would strengthen the evidence base regarding immersion in nature-based activities. As such, we recommend building up the capacity to gather such data, noted as an important priority for the Global South (Shuvo et al., 2020). It must also be acknowledged that sea swimming or snorkeling confer physiological benefits for those who perform it, something that was not the main focus of our study. The existing literature on cold water swimming of the Global North have documented various physical health benefits, including maintenance of hormonal systems and pulmonary function (such as in Huttunen, Rintamäki, & Hirvonen, 2001; Gibas-Dorna et al., 2016; Illidi, Stang, Melau, Hisdal, & Stensrud, 2021). However, there is a lack of literature documenting if such benefits may occur in the context of warm water bodies that future research in similar veins is much needed. Finally, our analysis is quantitative, and as has been argued by Britton et al. (2018b) and Wood, Vimercati, Ferrini, and Shackleton (2022), the immersive exposure to blue spaces is shaped by a constellation of complex social-geographical factors, that at the same time, may constrain the exposure itself. In-depth qualitative studies are thus needed to disentangle this web of factors to arrive at a more complete picture of why immersive wild swimming benefits mental well-being (Foley, 2017).

5. Conclusion

Our study found indications of the positive association between mental well-being and the immersive activity of sea swimming or snorkeling, in the context of tropical coastal blue spaces in a lower-middle-income country during the COVID-19 pandemic. This adds to the existing body of evidence that, so far, has been gathered almost entirely in high-income countries. The findings produced in this study also indicated a non-linear dose-response relationship in the interlinking of human health and nature, about which knowledge is limited. Overall, this study highlights the fact that blue spaces are potentially invaluable resources for maintaining mental well-being during times of stress, and access to these environments should be maintained and encouraged, especially for local populations.

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CRediT authorship contribution statement

Carya Maharja: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Radisti A. Praptiwi:** Project administration, Investigation, Data curation, Writing – review & editing, Visualization. **Bethany R. Roberts:** Data curation, Writing – review & editing, Visualization. **Karyn Morrissey:** and . **Mathew P. White:** Conceptualization, Development, Methodology, Writing – review & editing, Supervision. **Nuzulia M. Sari:** and . **Fauzan Cholifatullah:** Investigation, Data curation. **Jito Sugardjito:** Writing – review & editing, Supervision. **Lora E. Fleming:** Conceptualization, Writing – review & editing, Supervision.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jort.2022.100584.

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