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RESEARCH PAPER

Norwegian Outdoor Happiness: Residential Outdoor Spaces and Active Leisure Time Contributions to Subjective Well-being at the National Population Level at the Start of and During the COVID-19 Pandemic

Raul Grau-Ruiz[1] · **Helga Synnevåg Løvoll**[2] · **Gunvor Marie Dyrdal**[3]

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Abstract
Accumulating research shows that residential nature reliably promotes residents' subjective well-being (SWB) in complex ways. The present study investigates how self-reported proximity to different outdoor spaces relate to SWB in Norway. The effects of having proximity to recreation and hiking areas and the frequency of moderate-to-vigorous intensity leisure-time physical activity (MVLTPA) were estimated for five SWB measures (satisfaction with life, positive, and negative affect, mental well-being, and meaning in life). The study also estimated how outdoor spaces promote MVLTPA, and which of these relationships changed during the COVID-19 pandemic. Two Norwegian samples (collected in 2020 and 2021; $N = 34{,}904$) were explored using multiple linear and multinomial logistic regression analyses. Residential outdoor spaces predicted higher SWB across measures and MVLTPA frequency. Importantly, an inverted U-shaped relationship between MVLTPA and all SWB measures was found, with a tipping point coinciding with weekly MVLTPA. Last, during the pandemic, outdoor spaces became stronger predictors: hiking areas for mental well-being and meaning in life; and recreation areas for MVLTPA ($p < .05$). This study refines our understanding of these complex relations and contributes to setting these effects in perspective with other sociodemographic factors and SWB measures. Lastly, the importance of residential outdoor spaces upon the prospect of future pandemics is discussed.

Keywords Subjective well-being · Outdoor spaces · Leisure-time physical activity · COVID-19 pandemic

As accumulating research shows that our health and well-being are benefited by being in contact with nature (Bratman et al., 2019; Hartig et al., 2014), the interplay between natural features in the residential environment and well-being has gained attention in public health management (WHO's Norwegian network, n.d.). Examples of beneficial public environmental features are residential *outdoor spaces*, which include green and blue spaces. Simi-

Extended author information available on the last page of the article

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larly, the body of evidence concerning the role of *leisure-time physical activity* (LTPA) on well-being is well documented, with effects varying with activity type, frequency, duration, and intensity (Werneck et al., 2022; Wiese et al., 2018). As nature contact typically involves physical activity, it is important to disentangle the roles of living close to outdoor spaces and being physically active for promoting everyday well-being. Such a distinction gains importance when discerning how contextual factors, such as a pandemic, affect the outdoor space and well-being relationship at large.

Nationwide population-based research on the well-being benefits of outdoor spaces is currently limited. Such studies are valuable for policymakers because they provide highly generalisable knowledge, which is needed for promoting well-being for everyone and for developing sustainably. Such aims are listed as United Nations Sustainable Development Goals (SDGs) and implemented by local governments, including Norway (United Nations, n.d.). In Norway, over 90% of residents who live in close proximity to outdoor spaces think that this condition positively affects their well-being (Espedal & Svedman, 2020); however, exactly how, or how much remains unknown.

1 Living Close to Nature and Subjective Well-being

The notion of flourishing in nature is very old, but renewed scientific interest in disciplines such as environmental and positive psychology has empirically advanced this understanding in recent decades. Psychological science has focused on individual perceptions of well-being, or *subjective well-being* (SWB). SWB is commonly researched in relation to *hedonic* (focusing on, e.g., pleasure and absence of discomfort) and/or *eudaimonic well-being* (focusing on, e.g., virtue, excellence, or the development of potentials). These labels refer to complementary facets that are necessary to understand the depth of this human experience. Some indices associated with hedonic well-being include positive and negative affect and life satisfaction, whereas eudaimonic well-being has been associated with indices such as meaning in life and positive mental functioning (Huta & Waterman, 2014). Although some scholars associate SWB only with hedonic well-being, in our study we used it to refer to both types of well-being. Benefits to both hedonic and eudaimonic well-being have been empirically associated with nature connectedness (Capaldi et al., 2014; Pritchard et al., 2020). However, in studies linking greenspace or green exercise with SWB, the impacts on hedonic measures are better documented than eudaimonic measures (Houlden et al., 2018; Kelley, 2019). At the nationwide population level, some studies have investigated associations between SWB and residential public outdoor spaces or greenspace: in Denmark (Stigsdotter et al., 2010), the United States (Wortzel et al., 2021), Sweden (Klein et al., 2022), and an 18 cross-country comparison (White et al., 2021). Together, these studies show that at the nationwide population level, having greenspaces 50 to 1,000 m from home results in increased positive affect (Stigsdotter et al., 2010; White et al., 2021) and life satisfaction (Klein et al., 2022), and decreased negative affect (Stigsdotter et al., 2010; Wortzel et al., 2021), with better scores generally coinciding with closer distances. However, the diversity in well-being measures and proxies for the natural environment complicates comparing these results. In sum, these studies are limited to investigating a few of the mentioned SWB measures, with a focus on hedonic well-being while leaving unaddressed measures like meaning in life.

To better understand and explain the effects of nature on SWB, multiple theories concerning psychological, physiological, and behavioural perspectives have been developed (Li & Zhang, 2023). From a psychological perspective, Joye and Van den Berg (2011) argued that humans experience mental capacity restoration in contact with nature because processing natural elements/environments—often including fractal patterns—requires fewer cognitive resources than artificial elements/environments. From a physiological perspective, volatile organic compounds released by plants are found to support human health and SWB by acting as anticancer, anti-inflammatory, antiviral, antibacterial, and neuroprotective agents (Zorić et al., 2021). The stimulation of behaviours such as being physically active in nature is a widely recognised indirect process conducive to increases in SWB. At large, we observe that having closer outdoor spaces typically promote more active lives (Schipperijn et al., 2017). However, different types of outdoor spaces seem to stimulate physical activity differently. For example, Burrows et al. (2018) showed that only 10% of the study participants responded that they would go to the park to run or jog, whereas the rest responded that their motivation concerned walking, relaxing, or socialising. The size of the outdoor space also matters, with larger public outdoor spaces with well-maintained paths being associated with higher levels of physical activity for adults (Giles-Corti et al., 2005; Markevych et al., 2017). Based on GPS and accelerometery data, Marquet et al. (2022) noted that higher levels of physical activity occur in environments with more dense, diverse, well-connected built environments, and with higher amounts of vegetation.

We understand that residential outdoor spaces can promote SWB because they facilitate frequent experiences in which the mentioned mechanisms can apply. However, the relationships between environments and people are complex. For example, although the environment can produce changes or outcomes such as people's behaviours, thoughts, or emotions, people also modify the meanings and physicality of environments, which is understood as a mutually transactive relationship (Donald, 2022). In other words, the person–environment relationship is dynamic and bidirectional. In extension, a myriad of factors are expected to moderate the relationship between living close to nature and SWB (Hartig et al., 2014). As the COVID-19 pandemic has affected nations worldwide, and the risk of similar future pandemics is at the rise (Haileamlak, 2022), it constitutes a highly relevant contextual factor. More specifically, the pandemic resulted in reduced mental health (Hossain et al., 2020), decreased mobility and physical activity (Jakobsson et al., 2020). Considering the pandemic's restrictions and negative effects, together with the outdoor spaces' benefits listed so far, it is likely that residential outdoor spaces during the pandemic promoted LTPA and SWB at the population level beyond pre-pandemic conditions (Slater et al., 2020; Venter et al., 2020). Therefore, it is valuable to quantitatively estimate the effects of the COVID-19 pandemic for these relations.

1.1 Norway: A Naturally Happy Country?

To examine the relationships between outdoor spaces and SWB, the case of Norway is of special interest for several reasons. First, Norway is consistently ranked among the 10 happiest countries worldwide (Martela et al., 2020). Second, Norway is well-known for its nature, including mountain areas, forests, coastal lines, fjords, and aurora borealis. It is a large country with relatively few inhabitants and small green cities compared to central Europe, and it has rich access to outdoor spaces. Third, there is an active culture in Norway

that emphasises the value of outdoor engagement, as exemplified by Norwegian residents' definition of their understanding of 'health'. In open-ended interviews about health ($n=80$), 'nature' was among the most important aspects informants freely mentioned in a salutogenic understanding of well-being and well-functioning life (Fugelli & Ingstad, 2001). Fourth, outdoor recreation is practiced by over 92% of the inhabitants on a regular basis (Statistics Norway, 2021). Fifth, and crucially, annual national well-being examinations have been conducted since 2020. These surveys are aimed at producing nationally representative data and include measures of affective, cognitive, and eudaimonic SWB (Pettersen & Støren, 2020, 2021). The 2020 and 2021 surveys are of special importance because they included items pertaining to local outdoor environments and an extensive list of socio-demographic variables to control for.

In Norway, multiple types of public outdoor spaces can be identified based on certain criteria. The two types that have been included in the mentioned surveys are play and recreation areas (for simplicity, '*recreation areas'*) and *hiking areas*. According to the Norwegian Environment Agency (2014), hiking areas should be found within 500 m from residencies, schools, and kindergartens, be covered by vegetation, and be over 200,000 m^2, whereas recreation areas are smaller than hiking areas, should generally be closer to residences (within 200 m), and can be managed to a greater degree, for example, by including fields for practicing sports. These two categories of outdoor spaces are monitored in Norway because they are used as environment indicators and are associated with environmental goals motivated by the government's white paper about outdoor recreation (Meld. St. 18, 2015–2016) and the SDGs. For outdoor spaces to be actively used for physical activity and outdoor recreation in daily life, they must be found within 50–1000 m from people's homes. Therefore, the specific radiuses assigned to these outdoor spaces aim to promote public health, with the radius of recreation areas particularly reduced to ensure that children, adults, and elders, whose action radius is smaller, still have the possibility of daily outdoor recreation and physical activity (Environment Norway, 2023a, b).

Another circumstance that makes this data worth analysing is their timing in relation to the pandemic. The 2020 survey was conducted on March 9–29, and the country introduced on March 12th some of the most invasive measures Norway has had in peacetime. It included the shutdown of the country, travel restrictions and quarantines, the closing of education institutions and businesses where close physical contact was unavoidable, and the recommendations of home office regimes. Cultural arrangements were also forbidden. For a year, the country experienced the easing and reintroduction of measures due to new variants of the virus (Tjernshaugen et al., 2023). During the time the 2021 survey was being conducted (8–28 March), a large proportion of the Norwegian population was subject to very strict measures, with restrictions depending on local and regional outbreak conditions. The general recommendations were to avoid travelling, to limit social contacts, and to meet people and recreate outdoors, as well as to work from home and cancel or postpone events bringing people from more than one municipality together. As the national situation worsened by March 10th in 2021, the government considered extending to the national territory severe rules. Such rules included keeping 2 m of interpersonal distance, limiting to 10 social contacts per week, the prohibition of indoor organised sports and leisure activities for adults, the closing of fitness centres and swimming pools, and the limitations of events to fewer participants or even their postponement (Government.no, 2021).

In sum, it is well known that nature plays an important role in the Norwegian active-leisure culture, and yet little is known about the influence of local outdoor spaces on SWB (Espedal & Svedman, 2020). Moreover, as the state of the pandemic led to severe restrictions and recommendations from authorities to increase the use of local outdoor spaces, there is an added degree of interest in examining how these relationships developed within the 2020–2021 timeframe.

1.2 Study Aims and Hypotheses

A better understanding of the human–nature environment bond, as an essential ingredient of a life well-lived, has been a human interest since antiquity, which both endures and gains importance in our times. To advance our understanding, we intended a triple contribution. First, we sought to estimate how self-reported proximity to outdoor spaces and LTPA frequency affect SWB, including eudaimonic measures, which are rarer in the literature. Second, we assessed how different outdoor spaces predict LTPA frequency. Third, we tested for an expected effect of the COVID-19 pandemic on these relationships. To accomplish our goals, we used two nationally representative Norwegian samples obtained in consecutive years (2020–2021, $N=34{,}904$). Aware that other factors may be associated with both LTPA and SWB (Hartig et al., 2014), we controlled for a number of possible sociodemographic confounders included in these datasets. Building upon the key points indicated by this review, we hypothesised that:

(1) Proximity to outdoor spaces and more frequent moderate-to-vigorous intensity LTPA predict higher SWB (satisfaction with life, positive and negative affect, mental well-being, and meaning in life).
(2) Proximity to outdoor spaces, and especially hiking areas, predicts increased odds of more frequent moderate-to-vigorous intensity LTPA (Burrows et al., 2018; Giles-Corti et al., 2005; Markevych et al., 2017; Marquet et al., 2022).
(3) Some of these relationships are significantly stronger in 2021 than in 2020.

2 Methods

2.1 Participants and Procedures

The present study uses a trend and not a panel design, with different samples. Data was obtained from two waves of digital surveys financed by the Norwegian Directorate of Health and the Norwegian Directorate of Children, Youth and Family Affairs, conducted by Statistics Norway between 9–29 and 8–28 March in 2020 and 2021, respectively. A randomised selection of 80,000 people living in Norway aged 18 + were invited to participate in national quality of life surveys. The selection of participants was based on the Norwegian Population Registry. Email, letters, and SMS were used to disseminate information on the survey and its web link (Pettersen & Støren, 2020, 2021). For the present study, anonymised data from 34,904 respondents (17,417 from 2020) were obtained from the Norwegian Social Science Data Services (NSD) (Statistics Norway, 2022a, 2022b). While aiming to produce nation-

ally representative data, these samples are biased by education level, age, and birth country. Higher education, the 45–66 age group, and native Norwegians are overrepresented. To correct for sampling biases the datasets included weight variables (Pettersen & Støren, 2020, 2021).

2.2 Measures

2.2.1 Proximity to Outdoor Spaces

Respondents were asked to think about their residence and near environment. Proximity to outdoor spaces was assessed using two indicators. Respondents were asked whether there is an area that can be used for playing or recreation within 200 m from the residence and hiking areas within 500 m from the residence. Response options 'yes/no' and 'I don't know/want to answer' were available.

2.2.2 Frequency of moderate-to-vigorous intensity leisure-time physical activity (MVLTPA)

Participants were asked to think about their everyday lives and leisure time. One item was used to assess physical activity, namely 'Approximately how often do you do the following in the leisure time: Exercising or being physically active so that you become breathless or sweaty'. This item had six response levels: daily, weekly but not daily, monthly but not weekly, a few times a year, more seldomly, and never. To simplify the analyses and interpretations, the levels 'a few times a year' and 'more seldomly' were merged into 'rarely'. Response options 'I don't know/want to answer' were available.

2.2.3 Subjective Well-being

SWB was measured in accordance with a set of recommendations for measuring well-being in national public health surveys in Norway (Nes et al., 2018). The measures represented three dimensions of SWB: affective, cognitive, and eudaimonic well-being. The affective dimension was assessed with two measures: one for positive affect, which averaged the response on three items pertaining to the degree to which the respondent had felt happy, engaged/interested, and relaxed last week, and one for negative affect, which averaged the response on six items pertaining to the degree to which the respondent had felt worried, sad, irritated, lonely, anxious, and stressed in the last 7 days. These items were scored on a 0–10-point Likert scale. The cognitive dimension was assessed with the average score on the Satisfaction with Life scale (Diener et al., 1985), comprising five items on a 1–7-point Likert scale. The eudaimonic dimension was assessed with two measures: First, the average score of the OECD's question on experiencing life as meaningful (OECD, 2013) and Erik Nord's question on experiencing life as rich (one item each) (Nes et al., 2018), which together register the degree to which life is perceived as meaningful, substantial, and rewarding on a 0–10-point Likert scale. Second, the average score of the short version of the Warwick-Edinburgh Mental Well-being scale (Tennant et al., 2007), including seven items on a 1–5-point Likert scale, corresponded with how often the respondent had experienced aspects characterising good mental functioning in the last 14 days. Response options 'I

don't know/want to answer' were available, and higher scores represent better SWB, except for negative affect.

2.2.4 Confounder Variables

Sociodemographic information was obtained partially through answers to questions pertaining to people's living conditions, such as their economic solvency (6-point Likert scale from *very challenging* to *very easy*), whether the respondent lived with a spouse or partner, and employment status (both dichotomous). These responses were supplemented with personal information from the national population registry, including birth country (Norwegian born/other), birthdate (age was categorised in 5 intervals), gender (dichotomous), education level (3 levels), and urbanicity (5 intervals, from $\geq$*100,000 inhabitants* to $<$*200*).

2.3 Statistical Analyses

SPSS for Windows version 28.0 (IBM Corp., 2011) was used for the statistical analyses. After data preparation, the datasets were pooled, and weights were used. Descriptive statistics were used to present the sample characteristics. The study hypotheses were tested using regression techniques. Reference categories were selected aiming for easier or more meaningful interpretations. Response options 'I don't know/want to answer' in any of the items were regarded as missing. Missing values were treated with the listwise deletion method for every model. The significance level was set at $p \leq .05$, and 95% confidence intervals (*CI)* are given when appropriate.

Our first hypothesis was tested by regressing the SWB variables using linear regression models. The analysis first involved a series of unadjusted models with predictors: outdoor spaces, MVLTPA frequency, all confounders, and survey year. MVLTPA was entered into the model as dummy-coded to avoid assuming linearity and to report the expected SWB impacts associated with each frequency level. Similarly, age, education level, and urbanicity, which also have a few categories, were treated the same way. Only economic solvency was entered as a continuous predictor. Next, the SWB variables were regressed on adjusted models that entered these predictors simultaneously.

We considered testing our second hypothesis with ordinal regression techniques, but a significant result on the test of parallel lines made us choose multivariate multinomial logistic regression techniques (Liang et al., 2020). These models were calculated using maximum likelihood estimation. First, the MVLTPA frequency 'Never' was set as the reference category, and each predictor was entered as a factor. The frequency levels of MVLTPA were regressed on a series of unadjusted models with predictors: outdoor spaces, confounders, and survey year. Next, MVLTPA frequencies were regressed on these predictors entered simultaneously.

Our third hypothesis was assessed with interaction variables pertaining to outdoor spaces or MVLTPA with the survey year dummy-coded variable. These interactions were created and entered into a final additional step in all previously described fully adjusted models to test for effect changes (Firebaugh, 2010). However, interactions were only included in the ultimate models presented when their inclusion resulted in model improvement. Model improvement was considered when adding the interaction effect produced significant F change for multiple linear regression or significant χ^2 for multiple multinomial logistic

regression. High multicollinearity is common when testing moderation (Jaccard & Turrisi, 2003), so we were permissive of it, unless VIF values rose well over 10. Considering the high statistical power afforded by these datasets and the fact that even small effects yield importance at the population level (Hartig et al., 2014), we decided to keep and report any significant effects. For linear regressions, predictors' impacts are reported with their unstandardised beta (B), the standardised beta (β) to compare the relative strength of the associations between constructs, *p*, and CI to assess significance. Multinomial logistic regression results are reported with odds rates (OR), Walds', and the likelihood ratio (LR) test's *p* value.

3 Results

Descriptive statistics after weighting the data are presented in Table 1, and a supplementary version of this table before weighting the data is provided in the supplementary material Table 1. The mean age was 48 years; 50% were women, about 86% were born Norwegian, 66% lived with a spouse or partner, and most respondents (about 37%) were living in a city of over 100,000 inhabitants. Perceived proximity to outdoor spaces was high (approximately 88%) and slightly greater in 2021, particularly concerning hiking areas. The average frequency of MVLTPA was between monthly and weekly. The 2021 sample tended more towards higher levels of education than the 2020 sample, a higher employment rate (68.9% vs. 66.8%), and fewer people reporting economic difficulties (from 21.4% in 2020 to 19% in 2021).

Table 2 displays the results of the multiple linear regression models. Recreation areas, hiking areas, and MVLTPA significantly predict better scores throughout our five SWB models at $p<.05$. MVLTPA tended to be by far the strongest of these three predictors, followed by recreation areas, which in turn showed about double the β of hiking areas. Across the SWB measures, more frequent MVLTPA showed larger β, with a tipping point at weekly MVLTPA. All SWB indicators significantly worsened in 2021 compared to 2020. When exploring effect changes, we only found significance for hiking areas, which, in 2021, predicted further increases in meaning in life ($\beta=0.05$, $p=.004$) and mental well-being ($\beta=0.03$, $p=.033$). No other effect change was found.

Table 3 displays the results of our multinomial logistic regression model. Hiking areas predicted higher odds for every MVLTPA frequency compared to the reference value. Hiking areas predicted 22% greater odds for engaging in MVLTPA rarely, 26% for monthly, 39% for weekly, and 56% for daily compared to never doing so ($p<.05$ for each comparison). Recreation areas only showed significance for the comparison weekly-never, with 42% greater odds for engaging in weekly MVLTPA ($p<.001$). Survey year predicted between 40 and 33% reduced odds for engaging in MVLTPA frequency levels, with monthly MVLTPA showing the most dramatic decrease ($OR=0.60$, $p<.001$). Effect change was only found for recreation areas, which in 2021 predicted 46% greater odds for rare, 60% for monthly, 38% for weekly, and 63% for daily MVLTPA engagement ($p<.05$).

Table 1 *Characteristics of Study Samples Displayed by Survey Year. Analyses Used Survey Weights*

Variable	M ± SD or n (Valid %)			
	2020		2021	
Immigration background	2457	(14.2)	2350	(13.4)
Gender (% females)	8611	(49.7)	8750	(49.8)
Age	48.14	±18.43	48.35	±18.54
18–24 years old	1978	(11.4)	1938	(11)
25–44 years old	5881	(33.9)	6017	(34.2)
45–66 years old	6117	(35.3)	6186	(35.2)
67–79 years old	2464	(14.2)	2459	(14)
Over 80 years old	884	(5.1)	980	(5.6)
Education level				
Primary and secondary school (≤10 years of education)	5909	(35.7)	4124	(25.4)
High school (up to 13 years of education)	5104	(30.9)	6191	(38.1)
University college/university (≥bachelor's degree)	5520	(33.4)	5940	(36.5)
Employment status (% employed)	11,541	(66.8)	12,068	(68.9)
Difficult economic capability [a] (Economic solvency)	3693	(21.4)	3319	(19)
Living with a spouse or partner (Relationship)	11,509	(66.5)	11,607	(66.1)
Urbanicity				
≥100,000 inhabitants	6267	(36.6)	6512	(37.5)
20,000–99,999 inhabitants	2533	(14.8)	2666	(15.3)
2,000–19,999 inhabitants	3755	(21.9)	3664	(21.1)
200–1,999 inhabitants	1536	(9)	1497	(8.6)
<200 inhabitants	3027	(17.7)	3048	(17.5)
Outdoor spaces				
Having recreation areas within 200 m	15,180	(87.8)	15,420	(88)
Having hiking areas within 500 m	15,144	(87.5)	15,554	(88.7)
Leisure time physical activity (1–5)	3.47	±1.07	3.48	±1.08
1. Never	912	(5.3)	936	(5.3)
2. Rarely	2943	(17)	2940	(16.7)
3. Monthly	2610	(15.1)	2714	(15.5)
4. Weekly	8757	(50.6)	8697	(49.6)
5. Daily	2093	(12.1)	2264	(12.9)
Positive affect (0–10)	6.54	±1.98	6.37	±2
Negative affect (0–10)	3.10	±2.12	3.16	±2.18
Satisfaction with life (1–7)	5.11	±1.32	4.97	±1.34
Mental well-being (1–5)	3.78	±0.67	3.70	±0.69
Meaning in life (0–10)	7.09	±2.06	6.72	±2.16

[a] Proportion reporting it was somewhat difficult, difficult, or very difficult to cope with the family's daily expenses

Table 2 *Results From Multiple Linear Regressions of Subjective Well-being Measures. Analyses Used Survey Weights*

Variable	Subjective well-being														
	Satisfaction with life			Positive affect			Negative affect			Mental well-being			Meaning in life		
	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p
Constant	2.13	[2.04, 2.22]	<0.001	2.72	[2.58, 2.86]	<0.001	6.44	[6.28, 6.59]	<0.001	2.27	[2.22, 2.32]	<0.001	2.29	[2.14, 2.45]	<.001
Immigration background (RC=No)	.10 (.02)	[.06, .15]	<.001	.08 (.01)	[.01, .15]	.02	.02 (.00)	[−.06, .09]	.664	.01 (.01)	[−.01, .04]	.217	.42 (.06)	[.35, .49]	<.001
Gender (RC=Male)	.15 (.06)	[.13, .18]	<.001	−.02 (−.00)	[−.06, .03]	.449	.41 (.10)	[.36, .45]	<.001	.04 (.03)	[.02, .05]	<.001	.20 (.05)	[.16, .24]	<.001
Age (RC=18–24 years old)															
25–44 years old	−.24 (−.08)	[−.29, −.19]	<.001	−.03 (−.01)	[−.10, .05]	.481	−.09 (−.02)	[−.17, −.01]	.026	.05 (.03)	[.02, .07]	<.001	.07 (.02)	[−.01, .15]	.066
45–66 years old	−.17 (−.06)	[−.22, −.12]	<.001	.33 (.08)	[.26, .41]	<.001	−.65 (−.15)	[−.72, −.57]	<.001	.20 (.14)	[.18, .23]	<.001	.50 (.11)	[.43, .58]	<.001
67–79 years old	.15 (.04)	[.10, .21]	<.001	.61 (.11)	[.52, .70]	<.001	−1.21 (−.20)	[−1.30, −1.12]	<.001	.40 (.21)	[.37, .43]	<.001	1.01 (.17)	[.92, .1.11]	<.001
>80 years old	.33 (.06)	[.26, .40]	<.001	.32 (.04)	[.20, .43]	<.001	−1.23 (−.13)	[−1.35, −1.11]	<.001	.38 (.13)	[.34, .42]	<.001	1.03 (.11)	[.91, 1.14]	<.001
Education level (RC=Primary education)															
High school	.07 (.03)	[.04, .10]	<.001	.05(.01)	[.00, .10]	.047	−.08 (−.02)	[−.14, −.03]	.003	.04 (.03)	[.03, .06]	<.001	.07 (.02)	[.02, .12]	.008
University	.20 (.07)	[.16, .23]	<.001	.05 (.01)	[−.00, .10]	.083	−.06 (−.01)	[−.12, .00]	.05	.04 (.03)	[.03, .06]	<.001	.20 (.04)	[.14, .25]	<.001
Employment status (RC=Unemployed)	.34 (.12)	[.31, .38]	<.001	.45 (.11)	[.40, .51]	<.001	−.15 (−.03)	[−.21, −.10]	<.001	.14 (.09)	[.12, .15]	<.001	.72 (.16)	[.66, .77]	<.001
Economic solvency (Continuous, 6 levels)	.33 (.33)	[.32, .35]	<.001	.38 (.24)	[.36, .39]	<.001	−.42 (−.26)	[−.44, −.41]	<.001	.15 (.28)	[.14, .15]	<.001	.39 (.24)	[.37, .40]	<.001

Table 2 (continued)

Variable	Subjective well-being														
	Satisfaction with life			Positive affect			Negative affect			Mental well-being			Meaning in life		
	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p
Relationship (RC=No)	.53 (.19)	[.50, .56]	<.001	.31 (.07)	[.27, .36]	<.001	−.24 (−.05)	[−.29, −.19]	<.001	.14 (.10)	[.12, .15]	<.001	.59 (.13)	[.54, .64]	<.001
Urbanicity (RC=≥100,000 inhabitants)															
99,999–20,000 inhabitants	.00 (.00)	[−.04, .04]	.965	.03 (.01)	[−.03, .09]	.343	−.04 (−.01)	[−.10, .03]	.270	.02 (.01)	[−.00, .04]	.073	.05 (.01)	[−.01, .11]	.131
19,999–2,000 inhabitants	.03 (.01)	[.00, .07]	.05	.02 (.00)	[−.04, .07]	.524	−.09 (−.02)	[−.14, −.03]	.004	.02 (.01)	[.00, .04]	.036	.09 (.02)	[.03, .14]	.003
1,999–200 inhabitants	.08 (.02)	[.03, .13]	<.001	.16 (.02)	[.08, .23]	<.001	−.22 (−.03)	[−.30, −.14]	<.001	.04 (.02)	[.02, .07]	<.001	.20 (.03)	[.12, .27]	<.001
<200 inhabitants	.07 (.02)	[.03, .11]	<.001	.11 (.02)	[.05, .17]	<.001	−.22 (−.04)	[−.28, −.16]	<.001	.06 (.03)	[.04, .08]	<.001	.27 (.05)	[.21, .33]	<.001
Survey year (RC=2020)	−.18 (−.07)	[−.21, −.16]	<.001	−.21 (−.05)	[−.25, −.17]	<.001	.09 (.02)	[.05, .14]	<.001	−.14 (−.10)	[−.18, −.10]	<.001	−.59 (−.14)	[−.72, −.47]	<.001
Recreation areas (RC=No)	.24 (.06)	[.20, .28]	<.001	.32 (.05)	[.25, .38]	<.001	−.28 (−.04)	[−.35, −.21]	<.001	.13 (.06)	[.11, .16]	<.001	.41 (.06)	[.35, .48]	<.001
Hiking areas (RC=No)	.12 (.03)	[.08, .16]	<.001	.21 (.03)	[.14, .27]	<.001	−.11 (−.02)	[−.18, .04]	.002	.06 (.03)	[.03, .09]	<.001	.10 (.02)	[.01, .19]	.035
Leisure time physical activity (RC=Never)															
Rarely	.36 (.10)	[.30, .42]	<.001	.63 (.12)	[.53, .74]	<.001	−.24 (−.04)	[−.35, −.14]	<.001	.21 (.11)	[.17, .24]	<.001	.78 (.14)	[.67, .88]	<.001
Monthly	.49 (.13)	[.42, .55]	<.001	.82 (.15)	[.71, .92]	<.001	−.35 (−.06)	[−.46, −.24]	<.001	.28 (.15)	[.24, .31]	<.001	.98 (.17)	[.88, 1.09]	<.001
Weekly	.59 (.22)	[.53, .65]	<.001	1.03 (.26)	[.94, 1.13]	<.001	−.54 (−.13)	[−.64, −.44]	<.001	.34 (.25)	[.31, .37]	<.001	1.18 (.28)	[1.08, 1.27]	<.001

Table 2 (continued)

Variable	Subjective well-being														
	Satisfaction with life			Positive affect			Negative affect			Mental well-being			Meaning in life		
	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p	B (β)	95% CI	p
Daily	.67 (.17)	[.60, .74]	<.001	1.30 (.22)	[1.19, 1.40]	<.001	−.67 (−.10)	[−.78, −.55]	<.001	.41 (.20)	[.37, .44]	<.001	1.37 (.21)	[1.26, 1.48]	<.001
Effect change: Survey year by hiking areas	–	–	–	–	–	–	–	–	–	.05 (.03)	[.00, .09]	.033	.19 (.05)	[.06, .32]	.004
Full model statistics	R^2=.26, F=509.71		<.001	R^2=.16, F=273.80		<.001	R^2=.17, F=304.12		<.001	R^2=.22, F=401.15		<.001	R^2=.21, F=382.55		<.001

Note. RC=reference category; With these effect changes models improved (mental well-being: ΔR^2=0.00, F (1, 32,374)=4.54, p=.033; meaning in life: ΔR^2=0.00, F (1, 32,330)=8.45, p=.004)

Table 3 *Results From Multinomial Logistic Regression of Moderate-to-Vigorous Intensity Leisure Time Physical Activity. Analyses Used Survey Weights*

Variable	OR's and Wald's p test, and Likelihood Ratio p test				
	Daily	Weekly	Monthly	Rarely	p (LR)
Intercept	.89	.91	.46***	.90	
Immigration background (RC=No)	.74***	.52***	.62***	.84*	<.001
Gender (RC=Male)	.77***	1.04	1.02	.94	<.001
Age (RC=18–24 years old)					<.001
25–44 years old	.37***	.59***	.70***	.96	
45–66 years old	.47***	.73**	.59***	1.04	
67–79 years old	.43***	.69***	.43***	.94	
>80 years old	.14***	.19***	.15 ***	.39***	
Education level (RC=Primary education)					<.001
High school	1.52***	1.66***	1.66***	1.30***	
University	2.86***	3.34***	2.69***	1.54***	
Employment status (RC=Unemployed)	1.25**	1.72***	1.98***	1.45***	<.001
Economic solvency (RC=Very challenging)					<.001
Challenging	1.25	1.95***	1.79***	1.57***	
Somewhat challenging	1.53**	2.90***	2.19***	2.15***	
Somewhat easy	2.46***	4.48***	3.32***	2.44***	
Easy	2.83***	4.56***	2.92***	2.05***	
Very easy	2.86***	4.24***	2.38***	1.61***	
Relationship (RC=No)	1.21**	1.48***	1.59***	1.43***	<.001
Urbanicity (RC=≥100,000 inhabitants)					<.001
99,999–20,000 inhabitants	1.03	1.01	1.23*	1.01	
19,999–2,000 inhabitants	1.07	1.12	1.16	1.14	
1,999–200 inhabitants	1.07	1.12	1.25*	1.06	
<200 inhabitants	1.35***	1.17	1.34***	1.19*	
Survey year (RC=2020)	.63**	.64***	.60***	.67**	.004
Recreation areas (RC=No)	1.22	1.42***	1.21	1.05	<.001
Hiking areas (RC=No)	1.56***	1.39***	1.26**	1.22*	<.001

Table 3 (continued)

Variable	OR's and Wald's p test, and Likelihood Ratio p test				
	Daily	Weekly	Monthly	Rarely	p (LR)
Effect change: Survey year by recreation areas [a]	1.63**	1.38*	1.60**	1.46**	.016
Change − 2LL	3280.08	df=92		p<.001	
Goodness of fit [b]	40698.75	df=35,124		p<.001	

Note. The dependent variable has five levels, where the value 'never' is the reference value; RC=reference category

[a]With this effect change model improved (χ^2=12.16, df=4, p=.016)

[b]Due to many subgroups with zero frequencies (66.2%), these tests are not valid.

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$

4 Discussion

The results of the analyses support our hypotheses. Proximity to outdoor spaces and MVLTPA predicted increased SWB, and outdoor spaces predicted more frequent MVLTPA. Moreover, some of these relations were accentuated during the pandemic.

4.1 Outdoor Spaces and Physical Activity in Promoting SWB

The finding that outdoor spaces and more frequent MVLTPA predicted increased SWB widely matches previous research. Moreover, these findings allow refinement of our understanding of these relationships. For outdoor spaces, the effect was very small, yet often comparable to that of education level. Perceived proximity to hiking and recreation areas often showed similar β to having a high school and university-level education, respectively. We wondered why recreation areas consistently show stronger beneficial SWB impacts compared to hiking areas. At first, this finding was surprising, because we understand hiking areas to be larger and necessarily covered by vegetation. Further, because recreation areas are relatively small, a user may still be more exposed to urban elements, such as buildings or roads, or experience reduced biodiversity. Thus, considering the beneficial effects of nature on people's SWB and the fact that hiking areas seem to better represent a wilder environment, this finding is worth some elaboration.

According to item formulations, recreation areas may usually correspond with residents' most proximal outdoor spaces, and generally, more frequent exposure can be expected. As research in Sweden shows (Klein et al., 2022), the closer the greenspace from people's residence, the stronger the associations with satisfaction with life and lowered depressive symptoms. When these authors measured the satisfaction with life impact of residential greenspace at a 500 m buffer (just like our hiking areas variable), the β obtained by them was only slightly weaker than the value we obtained (0.02 vs. 0.03). However, in our samples and analyses, the impact of having recreation areas at a 200 m buffer is about double the size of having greenspace at a 50 m buffer in Sweden. The reason for this finding in our sample remains unclear. Multiple circumstances could have contributed, such as characteristics of our sample, particularities in our statistical models, or specific features in these recreation areas. For example, Klein et al.'s (2022) study showed that the associations were stronger when the buffer radius included water features.

We also noted that outdoor space impacts across SWB measures were quite homogeneous, except perhaps in the case of recreation areas for the measures on positive and negative affect, which were comparably a bit lower (absolute $\beta = 0.04$ to 0.05 vs. 0.06 for the rest of the measures). However, considering such small differences and that the models are not built identically, we are cautious about embarking on this interpretation. Moreover, we expected to find, to some extent, that different measures of SWB would be linked. As indicated by Pritchard et al. (2020), nature connectedness is equally associated with hedonic and eudaimonic well-being.

By contrast, we found that MVLTPA has a significant yet mostly small impact across SWB measures, which tends to increase with frequency, almost reaching a medium size in some cases. This impact can be compared to that of living with a partner (for satisfaction with life and negative affect), and to employment status or even economic solvency —generally the strongest of the SWB predictors examined— (for positive affect, mental

well-being, and meaning in life). Werneck et al. (2022) used linear models to regress mental well-being on LTPA's frequency and intensity as continuous predictors. In a side analysis, we replaced our MVLTPA categories for a continuous predictor in the same fully adjusted model presented in Table 2 and found that our results matched to some degree. However, of even greater importance is that daily MVLTPA did not show the largest β, whereas weekly did. This suggests that the MVLTPA–SWB relationship was not linear but quadratic, peaking at weekly but not daily frequency. Finding an inverted U-shaped relationship between physical activity and a mental health indicator is not new (e.g., Mutz et al., 2021). Previous research has found similar effects between exercise frequency and mental health burden, with a tipping point at exercising five times a week (Chekroud et al., 2018). Similarly, Richards et al. (2015) found that concerning vocational physical activity, those reporting some volume of physical activity had higher odds of being happier (affective well-being) than those reporting a lot of it. However, finding linear effects is also common; for example, Richards et al. (2015) found more generally that increasing volumes of physical activity was associated with higher levels of happiness, including leisure physical activity. We thus consider our finding important from a public health perspective, as a strong focus on increasing people's levels of physical activity may be understood as 'the more, the better'. We recognise that practicing daily MVLTPA shares similarities with high-performance sports training, which, from multiple aspects, should not be understood as healthy role models. The findings support the need to distinguish between obsessive and harmonious passion (Vallerand, 2012), as there could be elements of obsessive passion when engaging in moderate-to-vigorous physical activity is a daily habit. Last, our findings suggest that MVLTPA has a different effect across SWB dimensions, being weaker at reducing negative emotions and stronger for promoting meaning in life (absolute β for each frequency tended to be at least double in magnitude for meaning in life). A comparable trend was reported by Werneck et al. (2022), who showed a weaker effect of reducing negative affect than mental well-being, and Wiese et al. (2018), who found in their meta-analysis that LTPA is associated with positive affect and life satisfaction but not with negative affect. These findings could mean that despite the positive effects of exercising, it is not that effective at solving many root causes that produce negative emotions. Contrary, exercising in leisure time or doing some form of outdoor activity that connects one with nature may provide an effective context for promoting meaning in life. In line with the self-determination theory (Ryan & Deci, 2000), self-determined and autonomous behaviour promotes intrinsic motivation and a sense of purpose, which is a key facet in the experience of meaning in life (King & Hicks, 2021). Connecting with nature is also a way to experience meaning in life (Pritchard et al., 2020). Moreover, Yang et al. (2022) showed in a series of experiments that the satisfaction of the three psychological needs posited by the self-determination theory mediated the effects of nature on meaning in life.

4.2 Outdoor Spaces for Promoting Physical Activity

Recreation areas and hiking areas predicted increased odds of more frequent MVLTPA. In particular, hiking areas were predictive at every frequency level, whereas recreation areas were predictive only at the weekly level. These results confirm our second hypothesis and support previous research showing that residential outdoor spaces and active leisure are highly related.

For hiking areas, the effect on monthly or rare MVLTPA was comparable to that of living in a village with less than 200 inhabitants, whereas for weekly and daily LTPA, this effect was higher and comparable to having a high school education. For recreation areas, the effect on weekly MVLTPA was comparable to that of hiking areas. As living in urbanised spaces is a global trend, this finding shows how facilitating nearby public hiking areas can compensate for and even exceed the MVLTPA benefits of living in small rural centres. Therefore, these findings are valuable for urban planners. Moreover, as these findings reveal different patterns in promoting MVLTPA, they underscore the need to further nuance the study of outdoor spaces.

4.3 Effect Changes during the Pandemic

We hypothesised that some estimations would be significantly stronger in 2021 compared to 2020. Concerning SWB, this hypothesis was supported only for hiking areas for measures associated with eudaimonic SWB. One way of understanding this finding is that hiking areas buffered the SWB decline associated with the pandemic, thus contributing to maintaining a stable SWB. It is also relevant to reflect on why this applies only to hiking areas, especially given that recreation areas are likely the most proximal outdoor spaces for many respondents. One explanation could be that recreation areas were already stronger promoters of SWB and perhaps closer to the ceiling threshold. Alternatively, hiking areas may have specific qualities, such as a wilder natural character, which better stimulates people's mental well-being and meaning in life in the context of the life-changes induced by the pandemic. It is possible that hiking areas did not become more pleasant during the pandemic (maintaining hedonic well-being), but Norwegian residents may have interacted with them in new ways that magnified their importance, for instance, in coping with life challenges, adopting functional perspectives and habits, or feeling connected (stimulating eudaimonic well-being).

In relation to promoting the odds of MVLTPA's frequency, only recreation areas accounted for significant accentuations in 2021. Even when the estimated reductions of MVLTPA in 2021 were considered, those perceiving access to recreation areas not only compensated but possibly increased their MVLTPA. Moreover, in 2021, recreation areas were likely even more predictive of MVLTPA than hiking areas across frequency levels. Once again, a ceiling threshold concerning hiking areas may explain the lack of effect change. However, we think that given the similarities between MVLTPA and physical training, the fact that training centres and sports or cultural events were restricted during the pandemic can suggest that Norwegian residents found substitutes in proximal recreation areas as training spaces. Considering that most respondents reported proximity to outdoor spaces, the findings illustrate the importance of these spaces for public mental health, especially in times of crisis.

4.4 Strengths and Limitations

Some of the most salient strengths of our study include being the first densely controlled examination of multiple SWB measures in relation to two types of residential outdoor spaces and frequency levels of LTPA while accounting for the extraordinary situation of a pandemic. Our study allows for comparisons between several components of hedonic well-being and, more importantly—due to scarcity—eudaimonic well-being, including mean-

ing in life. We remark that investigating the meaning in life measure has been essential to register, for example that MVLTPA is a predictor of a very comparable importance as is people's economic solvency, and not only in relation to predicting SWB through increased positive affect. In addition, we could identify the strongest SWB effects of hiking areas, which appeared during the pandemic. We are also pioneers in studying these relationships in Norway, with a large sample and at a representative national level. Thus, we are confident that our study makes important contributions.

However, our study has important limitations. First, the cross-sectional design makes it impossible to address causality in these associations. Second, although these data are the best we have for the purposes of our study, we recognise that these estimations are based on people's perceptions, which may diverge widely from objective measures. Third, many other important aspects of living close to outdoor spaces (such as actual distance, size of area, and ecological and aesthetic aspects) and LTPA (such as types of physical activity and other intensities) remain unaddressed. Fourth, the natural, societal, and cultural contexts are expected modifiers of the studied relationships (Hartig et al., 2014), and the conditions in Norway regarding nature's qualities, accessibility, and culture are exceptional. Although Nordic countries and a few non-Nordic countries, like New Zealand, Scotland, Switzerland, or parts of Canada, also have somewhat comparable conditions, and would possibly show shared trends, we recognise that a global generalisability of these findings is challenged. For example, in countries where there is greater variability in people's access to green space, having close access could become a greater privilege, strengthening some or all of these relationships. However, many other factors, e.g., nature's characteristics or people's views on nature, could be even more influential. Fifth, although we consider Norwegian residents to have relatively small intersubjective differences in relation to their relationship with nature, and we were interested in general population lines, it is clear that testing for interactions concerning sociodemographic characteristics could have provided important nuances.

4.5 Implications and Future Research

Notably, about 90% of our samples reported proximity to outdoor spaces. A shortage of access was not a main concern. Thus, the findings underscore the importance of outdoor spaces when investigating physical activity and SWB at the population level, as these small benefits at individual level likely result in great societal impacts. Additionally, the obtained protective effect of outdoor spaces during the pandemic is another reason to consider these areas worth investing in, especially given the prospect of more frequent pandemics being expected (Haileamlak, 2022). Overall, these findings corroborate the need to plan for public residential outdoor spaces and carry implications for how to do so.

The finding of a reduction in all SWB measures, and in particular 'meaning in life', with a drop of $\beta = 0.07$ from weekly to daily MVLTPA, suggests that future research should account for a possibly quadratic relationship between SWB and physical activity. As our study to our knowledge is the first in-depth examination of these relationships, we found that our series of linear and multinomial regressions were adequate and valuable. However, future studies focused on assessing the total and mediated effects of outdoor spaces on SWB would benefit from structural equation modelling. For example, mediational analysis could shed light over complex dynamics between outdoor spaces, meaning in life, and SWB, as meaning in life seem to fully mediate the relationship between nature connectedness and

SWB (Howell et al., 2013). Widening the scope of environment-sensitive determinants of SWB, such as an increased sense of community (Hartig et al., 2014), or nature connectedness—which is not yet included in these yearly national surveys—would also help disentangle and enrich our knowledge of the environment–SWB relationships.

5 Conclusion

In pioneering the estimate of the kinds and magnitudes of hedonic and eudaimonic impacts of living close to nature in Norway at the population level, we found that residential outdoor spaces predicted significant SWB increases across measures and MVLTPA frequency. In turn, MVLTPA predicted significant small SWB increases across measures, with a tipping point at weekly MVLTPA found for all SWB measures. During the pandemic, the promotion of mental well-being, and especially meaning in life, exerted by hiking areas and the promotion of MVLTPA by recreation areas were accentuated. These contributions refine our understanding on the complex relations between residential outdoor spaces, MVLTPA, and SWB; and permit to set these effects in perspective with many other sociodemographic factors and SWB measures. Moreover, the importance of residential outdoor spaces upon the prospect of future pandemics was discussed. Altogether, our study suggests that almost 90% of Norwegian residents gained part of their SWB from living close to nature, and thus, these spaces can be regarded as an invaluable source of 'outdoor happiness'. The study findings carry implications for sustainable well-being planning and warrant further research.

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Declarations

Conflict of Interest The authors declare that they have no conflicts of interests.

Compliance with Ethical Standards The Norwegian Social Science Data Services (NSD) approved our request and granted anonymised data for our research purposes. Data originates from the Norwegian national Quality of Life Surveys in 2020 and 2021, which Norwegian residents voluntarily participated in.

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Authors and Affiliations

Raul Grau-Ruiz[1] · Helga Synnevåg Løvoll[2] · Gunvor Marie Dyrdal[3]

✉ Raul Grau-Ruiz
raul.grau-ruiz@hivolda.no

Helga Synnevåg Løvoll
helga.synnevag.lovoll@hivolda.no

Gunvor Marie Dyrdal
gunvor.dyrdal@ntnu.no

[1] Department of Social Sciences and History, Volda University College, Volda, Norway

[2] Department of Sports, Physical Education and Outdoor Studies, Volda University College, Volda, Norway

[3] Department of Health Sciences, Norwegian University of Science and Technology, Gjøvik, Norway