CATHOLIC UNIVERSITY OF VALENCIA "SAN VICENTE MÁRTIR"

The influence of contact with nature on physical activity practice and health status together with the effect of virtual nature on cognitive performance and mental health in university students

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To those who know my true potential.

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I still remember my first day at University and how my mother dragged me to the door and responded with that smile of hers, to one of my already forgotten faces at that time. And here we are now, eight years later, with a dissertation in my hands and a life purpose about to be fulfilled. The road to this achievement has been long and challenging, but thanks to the support of my family, tutors and university, I have been able to overcome the obstacles encountered in this journey.

First of all, I would like to express my most sincere thank you to my mother, who has been my constant rock throughout my academic life. Her unconditional love and support have been fundamental to my success, and I am grateful for her faith in me, even in the most difficult of times. Without a doubt, all of this would not have been possible without her constant encouragement and dedication. Secondly, I would like to dedicate a simple but powerful word to Alexandra, my girlfriend and life partner: Thank you!

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And having arrived at this stretch of the adventure, it is only fitting that we mention the key point one realizes in these moments: "This is not the end of something big, but the beginning of something huge."

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GLOSSARY OF ABBREVIATIONS

- **ART.** Attention Restoration Theory
- **CN.** Contact with Nature
- **CNS.** Connectedness to Nature Scale
- **CRT.** Conditioned Restoration Theory
- **DST.** Digit Span Test
- **ECN.** *Escala del Contacto con la Naturaleza*
- **GE.** Green Exercise
- **GSs.** Green Spaces
- **HPUs.** Health Promoting Universities
- **IPAQ-SF.** International Physical Activity Questionnaire - Short Form
- **MTM.** Multi-Theory Model
- **NBIs.** Nature-Based Interventions
- **NCDs.** Non-communicable Diseases
- **NCP.** Nature's Contribution to People
- **NDVI.** Normalized Difference Vegetation Index
- **NES-II.** Nature Exposure Scale II
- **NVRI.** Nature Virtual Reality Interactive
- **NVRNI.** Nature Virtual Reality Non-Interactive
- **PA.** Physical Activity
- **SF-12.** 12-Item Short Form Health Survey
- **SRT.** Stress Reduction Theory
- **SSQ.** Simulator Sickness Questionnaire
- **TMT.** Trail Making Test
- **VAS.** Visual Analogue Scale
- **VN.** Virtual Nature
- **VR.** Virtual Reality

ABSTRACT

Background: The present work investigates the intricate relationships between individuals' interaction with the natural environment, physical activity levels, and overall well-being, particularly focusing on university students. Drawing on a diverse range of literature, the investigation recognizes the multifaceted nature of such interactions, spanning socio-cultural engagement, lifestyle choices, and the impact on mental and physical health.

The literature review establishes the foundation by highlighting the positive effects of exposure to natural spaces on mental and physical health, emphasizing the importance of early exposure in young life for long-term well-being. The concept of green exercise is introduced, demonstrating the potential benefits of combining physical activity with nature. Alarming sedentary lifestyles and obesity rates prompt an exploration into the negative consequences, indicating the necessity for promoting healthy habits and human-nature interaction.

Purpose: The main research question centers on examining the strength of the relationship between health, physical activity, and interaction with the natural environment in university students. The investigation seeks to fill a gap in existing literature by analyzing and quantifying the impact of exposure to natural settings on physical activity levels and overall health alongside the effect of virtual nature on cognitive performance and mental health in university students.

Methods: This research is divided into several experiments. First, there are a couple of observational studies, one of which was conducted on a national level and the second one on an international level, carried out through a questionnaire. Secondly, an experimental study focusing on virtual reality was also conducted.

The observational study justifies its existence by acknowledging the proven positive correlation between health, physical activity and nature exposure while aiming to quantify the impact and the relationship between these elements. Specific tests are used to analyze different aspects, including sustainability measures, establishing unique correlations among variables not previously explored in the same context. The focus on university students adds a novel dimension, considering a demographic prone to stress and depression.

The experimental study extends the exploration into the realm of Virtual Reality and Virtual Nature, recognizing the lack of information on the impact of interactive and non-interactive VR environments on cognitive performance and well-being. This segment

aims to bridge the gap by investigating the effects of interactive VR as a virtual counterpart to physical activity, showcasing the international collaboration with the University of Zadar.

Results: The investigation provides insights into the multifaceted connections between individuals, nature, physical activity, and well-being, offering implications for health promotion and sustainability, particularly among university students. In the statistical examination, the data reveal a robust correlation among all primary variables (CN, health, PA, PA in nature, and characteristics of GSs). The sole variable that lacks correlation with all of them is the number of sitting hours, showing no association with distance, the quantity of GSs, and PA in nature. Additionally, in the context of path analysis, the fit indices for the examined model were as follows: $\chi 2$= 35.51; df = 9; p=.000; CFI = 0.970; ILI = 0.941; RMSEA = 0.065 (0.043, 0.088 90% CI); SRMR = 0.037. These results suggest a satisfactory fit of the model to the data across all parameters, with the exception of the chi-square value.

Likewise, it gives the importance of new technologies such as virtual nature as a complement to the mental well-being of university students. The primary findings indicate superior data for participants in the VN groups as opposed to the control group concerning well-being (stress control=3.36 / happiness=55.80 compared to NVRNI stress=2.29 / happiness=70.33 and NRVI stress=2.14 / happiness=71.91). However, no statistically significant differences were observed between the VN groups. When examining stress, happiness, and tenseness, notable main effects were observed at the time of assessment, along with a significant interaction effect with the VN groups. Within the cognitive domain, the VR groups accounted for 3.6% of the variance in "tmta" and 4.4% in "tmtb" while contributing 1.7% for "dst" although no discernible group effects were evident in cognitive tests for VN.

Conclusions: This comprehensive dissertation contributes new knowledge by exploring the nuanced connections between nature exposure, physical activity, health status and academic performance in university students.

This research highlights the complex interplay between environmental, physical activity, health, and academic factors, emphasizing the need for multidisciplinary approaches. The findings suggest that contact with nature positively influences the well-being and physical activity of university students, highlighting the role of green spaces. The study has practical implications for public health interventions, urban planning and wellness strategies emphasizing the importance of conducting further research to quantify the impact of nature-based interventions on this population. The work aligns with the growing body of literature in nature-based citizen science, emphasizing the need for meaningful connections between the natural environment, health, and urbanization to improve social well-being.

Furthermore, the inclusion of sustainability measures and the exploration of Virtual Nature add unique dimensions to the research, providing a holistic understanding of the subject matter. This study supports the idea that nature's stress reduction may involve conditioning. A stronger nature connection is linked to enhanced well-being, aligning with the biophilia hypothesis. Virtual nature is found to reduce stress and boost mood for university students. While cognitive performance showed no significant differences, tailoring virtual nature interventions based on individual nature connections could enhance their impact, providing practical implications for well-being among students.

KeyWords: Nature Exposure, Green Exercise, Physical Activity, Health Status, University students, Human-nature Interaction, Lifestyle, Green Spaces, Virtual reality, Cognitive Performance, Mental Health.

RESUMEN

Antecedentes: El presente trabajo investiga las intrincadas relaciones entre la interacción de los individuos con el entorno natural, los niveles de actividad física y el bienestar general, centrándose particularmente en los estudiantes universitarios. Basándose en una amplia gama de literatura, la investigación reconoce la naturaleza multifacética de tales interacciones, que abarcan el compromiso sociocultural, las elecciones de estilo de vida y el impacto en la salud física y mental.

La revisión de la literatura establece las bases al resaltar los efectos positivos de la exposición a espacios naturales en la salud física y mental, enfatizando la importancia de la exposición temprana en la vida joven para el bienestar a largo plazo. Se introduce el concepto de ejercicio verde, demostrando los beneficios potenciales de combinar la actividad física con la naturaleza. Los alarmantes estilos de vida sedentarios y las tasas de obesidad impulsan una exploración de las consecuencias negativas, lo que indica la necesidad de promover hábitos saludables y la interacción entre el ser humano y la naturaleza.

Propósito: La principal pregunta de investigación se centra en examinar la fuerza de la relación entre la salud, la actividad física y la interacción con el entorno natural en estudiantes universitarios. La investigación busca llenar un vacío en la literatura existente analizando y cuantificando el impacto de la exposición a entornos naturales en los niveles de actividad física y la salud general junto con el efecto de la naturaleza virtual en el rendimiento cognitivo y la salud mental en estudiantes universitarios.

Métodos: Esta investigación se divide en varios experimentos. En primer lugar, hay un par de estudios observacionales, uno de los cuales se realizó a nivel nacional y el segundo a nivel internacional, realizados a través de un cuestionario. En segundo lugar, también se llevó a cabo un estudio experimental centrado en la realidad virtual.

El estudio observacional justifica su existencia reconociendo la correlación positiva probada entre la salud, la actividad física y la exposición a la naturaleza, al tiempo que pretende cuantificar el impacto y la relación entre estos elementos. Se utilizan pruebas específicas para analizar diferentes aspectos, incluidas las medidas de sostenibilidad, estableciendo correlaciones únicas entre variables no exploradas previamente en el mismo contexto. El enfoque en los estudiantes universitarios añade una dimensión novedosa, considerando un grupo demográfico propenso al estrés y la depresión.

El estudio experimental amplía la exploración al ámbito de la Realidad Virtual y la Naturaleza Virtual, reconociendo la falta de información sobre el impacto de los entornos de

realidad virtual interactivos y no interactivos en el rendimiento cognitivo y el bienestar. Este segmento tiene como objetivo cerrar la brecha investigando los efectos de la realidad virtual interactiva como contraparte virtual de la actividad física, mostrando la colaboración internacional con la Universidad de Zadar.

Resultados: La investigación proporciona información sobre las conexiones multifacéticas entre los individuos, la naturaleza, la actividad física y el bienestar, ofreciendo implicaciones para la promoción de la salud y la sostenibilidad, particularmente entre los estudiantes universitarios. En el examen estadístico, los datos revelan una correlación sólida entre todas las variables primarias (CN, salud, AF, naturaleza de la AF y características de los EVs). La única variable que carece de correlación con todas ellas es el número de horas sentado, no mostrando asociación con la distancia, la cantidad de EVs y la naturaleza de la AF. Además, en el contexto del análisis de trayectoria, los índices de ajuste para el modelo examinado fueron los siguientes: $\chi 2$= 35,51; gl = 9; p=.000; CFI = 0,970; ILI = 0,941; RMSEA = 0,065 (0,043; 0,088 IC del 90 %); SRMR = 0,037. Estos resultados sugieren un ajuste satisfactorio del modelo a los datos en todos los parámetros, con excepción del valor de chi-cuadrado.

Asimismo, da la importancia de las nuevas tecnologías como la virtualidad como complemento al bienestar mental de los estudiantes universitarios. Los hallazgos principales indican datos superiores para los participantes en los grupos NV en comparación con el grupo de control en cuanto a bienestar (control del estrés = 3,36 / felicidad = 55,80 en comparación con estrés NVRNI = 2,29 / felicidad = 70,33 y estrés NRVI = 2,14 / felicidad = 71,91).). Sin embargo, no se observaron diferencias estadísticamente significativas entre los grupos de NV. Al examinar el estrés, la felicidad y la tensión, se observaron efectos principales notables en el momento de la evaluación, junto con un efecto de interacción significativo con los grupos NV. Dentro del dominio cognitivo, los grupos de RV representaron el 3,6% de la varianza en "tmta" y el 4,4% en "tmtb", mientras que contribuyeron con el 1,7% para "dst", aunque no se evidenciaron efectos grupales discernibles en las pruebas cognitivas para NV.

Conclusiones: Esta disertación integral aporta nuevos conocimientos al explorar las conexiones matizadas entre la exposición a la naturaleza, la actividad física, el estado de salud y el rendimiento académico en estudiantes universitarios.

Esta investigación destaca la compleja interacción entre factores ambientales, de actividad física, de salud y académicos, enfatizando la necesidad de enfoques multidisciplinarios. Los hallazgos sugieren que el contacto con la naturaleza influye positivamente en el bienestar y la actividad física de los estudiantes universitarios, destacando el papel de los espacios verdes.

El estudio tiene implicaciones prácticas para las intervenciones de salud pública, la planificación urbana y las estrategias de bienestar, enfatizando la importancia de realizar más investigaciones para cuantificar el impacto de las intervenciones basadas en la naturaleza en esta población. El trabajo se alinea con el creciente cuerpo de literatura sobre ciencia ciudadana basada en la naturaleza, enfatizando la necesidad de conexiones significativas entre el medio ambiente natural, la salud y la urbanización para mejorar el bienestar social.

Además, la inclusión de medidas de sostenibilidad y la exploración de la Naturaleza Virtual añaden dimensiones únicas a la investigación, proporcionando una comprensión holística del tema. Este estudio respalda la idea de que la reducción del estrés de la naturaleza puede implicar condicionamiento. Una conexión más fuerte con la naturaleza está vinculada a un mayor bienestar, lo que se alinea con la hipótesis de la biofilia. Se ha descubierto que la naturaleza virtual reduce el estrés y mejora el estado de ánimo de los estudiantes universitarios. Si bien el rendimiento cognitivo no mostró diferencias significativas, adaptar las intervenciones virtuales en la naturaleza en función de las conexiones individuales con la naturaleza podría mejorar su impacto, proporcionando implicaciones prácticas para el bienestar de los estudiantes.

Palabras clave: Exposición a la naturaleza, Ejercicio verde, Actividad física, Estado de salud, Estudiantes universitarios, Interacción humano-naturaleza, Estilo de vida, Espacios verdes, Realidad virtual, Desempeño cognitivo, Salud mental.

Chapter 1: INTRODUCTION

1.1. Preface

There are a variety of ways in which people engage with the natural environment for socio-cultural purposes and/or as a source of physical and mental health. This contact with nature represents the interaction of people with different living systems in open spaces such as parks, gardens, forests, beaches, mountains, deserts, etc. (Kazdin & Vidal-González, 2021).

According to Herrick (2020), our health is linked to our lifestyle and our interaction with the environment. Similarly, the quality of the environment can be altered by changes in the environment and the various pollutants caused by human activity.

Current evidence confirms that the exposure to natural spaces has a positive impact on both our mental and physical health, but it also has a positive impact on people's well-being and quality of life (White et al., 2019). Furthermore, early exposure in childhood can positively contribute to mental health in adolescence and adulthood (Engemann et al., 2019), having different effects depending on age (Bos et al., 2016) or gender (Sillman et al., 2022).

One of the most effective health tools we have is physical exercise (Wu et al., 2017; Lahart et al., 2019; Mnich et al., 2019), and by combining it with nature, a new concept emerges: green exercise. At a general level, green exercise can be divided into three levels, depending on the degree of exposure: First, it is found the observation of nature (real and virtual), which leads to improvements in mood and stress recovery (Brown et al., 2013; Twohig-Bennett & Jones, 2018); secondly, it is observed direct exposure, such as the exercise itself, where, for example, Bratman et al. (2015) observed reduced ruminative thinking and lower local brain activation of this region when walking in nature compared to walking in an urban area; and thirdly, gardening or camping as activities of interventions with nature (Han & Wang, 2018).

Sedentary lifestyles and obesity rates are getting worse. For example, in the European Health Survey 2020, 46.5% of men and 54.8% of women in Spain reported that they did not engage in any physical activity in their spare time. As a result, this lifestyle has a negative impact on both quality of life and life expectancy (Lee et al., 2012; Anstey et al., 2014).

As a final word, maintaining good healthy habits and a healthy interaction with nature because of their impact at the psychosocial level (Wood & Smyth, 2020; Oh, R. R. Y., 2021) is essential, and awareness should be raised among the youth population about it. Current evidence suggests that better subjective well-being and lower stress are closely related to our

physical health, including morbidity and mortality; i.e. the better one feels, the less susceptible one is to physical illness (Diener et al., 2017; Ngamaba et al., 2017).

As a result, with a population whose prevalence of global mental illness remains quite high, around 20 to 25% at some point in their lives (Charlson et al., 2019; Kessler et al., 2005), contact with nature becomes a direct tool full of benefits for people, thanks to the virtues and effects revealed (Kazdin & Vidal-González, 2021). It is because of the aforementioned reasons that the main idea of the study stems from the search for an answer to whether there is a relationship, or rather how strong the relationship is, between health, good levels of physical activity and interaction with the natural environment in university students (Thompson et al., 2011).

1.2. Justification of the Dissertation

This dissertation is configured as an innovative and relevant investigation at the confluence of the relationship between exposure to nature, physical activity and well-being in university students. Despite the abundant literature highlighting the psychological and physiological benefits of interaction with natural environments, there is a notable lack of studies that explore how these interactions impact the university population (Cage et al., 2021; Ratcliffe, 2021).

The originality of this dissertation is manifested in its multidimensional approach when considering various aspects, from exposure to traditional natural environments to the foray into the application of emerging technologies such as Virtual Reality. The inclusion of Virtual Reality and Virtual Nature adds a unique dimension to the investigation, as the interactivity of these virtual environments raises significant questions about their equivalence to conventional physical activity and their consequences on well-being.

The specific choice of the university population responds to its vulnerability to mental health problems, this population being a demographic group prone to high levels of stress and depression. This approach not only provides a more detailed understanding of the relationship between nature, physical activity and well-being in this particular group, but also addresses a gap in existing research that often focuses on younger or older populations (Almanza et al.,2012; (Noordzij et al., 2021).

The lack of comprehensive research on the influence of nature on physical activity, coupled with the paucity of studies addressing the application of VR in health and academic performance contexts, highlights the urgent need for this investigation. The results obtained

from this research could have significant implications for the design of public health interventions aimed at improving the quality of life of university students (Léger & Mekari, 2022; Li et al., 2021).

In summary, this dissertation is positioned as a comprehensive and innovative project that seeks to fill existing knowledge gaps in research on the relationship between nature, physical activity and health status, especially in the university context. The results are expected to contribute to the general understanding of these links and provide valuable information to address emerging challenges in promoting nature in today's society.

1.2.1. Justification of the Observational Studies

Current evidence proves the existence of a strong positive relationship between key levels of mental health and contact with nature, including improvements in mood, happiness, well-being, sleep, cognitive function, among others (Bratman et al., 2019; Frumkin et al., 2017; Weeland et al., 2019); however, the effect of exposure to these natural media on physical activity levels and their impact on overall health would still remain to be analyzed and, above all, quantified.

In order to be able to draw more specific conclusions, each section has been divided in a differentiated way with specific tests for this purpose (Akpınar, 2019; Jimenez et al., 2021). Furthermore, to accomplish making the study more unique, the section of sustainability has been added, in which it was asked for both the distance and the quality as well as the quantity of Green Spaces (henceforth referred to as GSs) in the residential area (Nguyen et al., 2021; Ruijsbroek et al., 2017; Geneshka et al., 2021) so as to establish possible relationships with the other data in the study and draw new conclusions with these groups of variables.

In short, these studies focus on the generation of new knowledge based on the contribution of data and numerical values of all the study variables described, together with the originality of establishing correlations between variables that have not been analyzed in the same research as in this case. Lastly, the reference population chosen was university students, since most similar studies focus mainly on children (Almanza et al., 2012; Cleland et al., 2008) or on the elderly (Noordzij et al., 2021; Petersen et al., 2018).

Therefore, having data on this population, which is particularly prone to suffer of *high levels of stress and depression*, among others, will generate more bibliographic information on the effect of nature dose in this population (Meredith et al., 2020) and the relationship they have with the exposure to the natural environment (Sharma et al., 2020). In this sense, this

project is immersed in nature-based citizen science (Cooper et al., 2009), which is defined as a highly collaborative and multidisciplinary effort that pretends to achieve mutual benefits for participants and researchers. The reason behind this is the growing body of scientific literature, which aims to make meaningful connections between the relationship between the natural environment, people's health and urbanization in order to raise awareness for improving social well-being (Williams et al., 2021).

1.2.2. Justification of the Experimental Study

As there is still little information available on the application of Virtual Reality (VR) in Virtual Nature (VN), there is a need for further research to investigate the impact of VR on health and wellness issues. And while the benefits of nature have been studied for years (Diaz et al., 2018; Jiménez et al., 2021) , and more recently so has been done with its virtual version as well (Browning et al., 2020), little is known about the same effects between an interactive and non-interactive virtual environment; this interactivity can be understood as a kind of simile of physical activity in a virtual way (Li et al., 2021).

As content presented through VR can be interactive or non-interactive, Choi & Paik (2018) note that interactive VR is considered more interesting and motivating to promote respondent engagement than non-interactive VR. This comparison is also carried out in a new way, taking into account a key academic element such as cognitive performance and memory. It is also worth noting that this study is the result of an international collaboration during the author's international stay with the University of Zadar.

Chapter 2: THEORETICAL FRAME

2.1. Contact with Nature

2.1.1. Contact with Nature and Health

As humans we have always been curious and interested in nature, mainly because it is essential for our survival. Therefore, knowledge of the natural environment has influenced and driven scientific knowledge and technology, as well as its transformation and use.

Nature and health are two essential components of human life that influence our well-being profoundly, and they are interrelated in countless ways. This is why in recent years, there has been a growing interest in the relationship between the natural environment and human health.

With the advancement of modern society, our health is increasingly deteriorating in harmony with the natural environment. As a result of this symbiotic relationship, the health of the population is affected by the degradation of nature (Mumtaz et al, 2022). Furthermore, it is estimated that 10% of the world's population suffers from a diagnosed mental disorder, depression and anxiety being the most common among adults (Saloni, 2021); in economic terms, the combined direct and indirect costs of mental disorders in the European Union (EU) are estimated to be around €798 billion per year (Trautmann et al., 2016).

When it comes to university, today's students often experience stress and mental exhaustion as a result of several factors, such as their demanding daily schedules (Boulton et al., 2019), learning tasks that require high cognitive skills (Van Merrienboer & Sweller, 2005), and the intensive use of digital devices for their assignments (Di et al., 2019). The issue of poor mental health among students in higher education is becoming increasingly important in terms of public health and policy (Storrie et al., 2010).

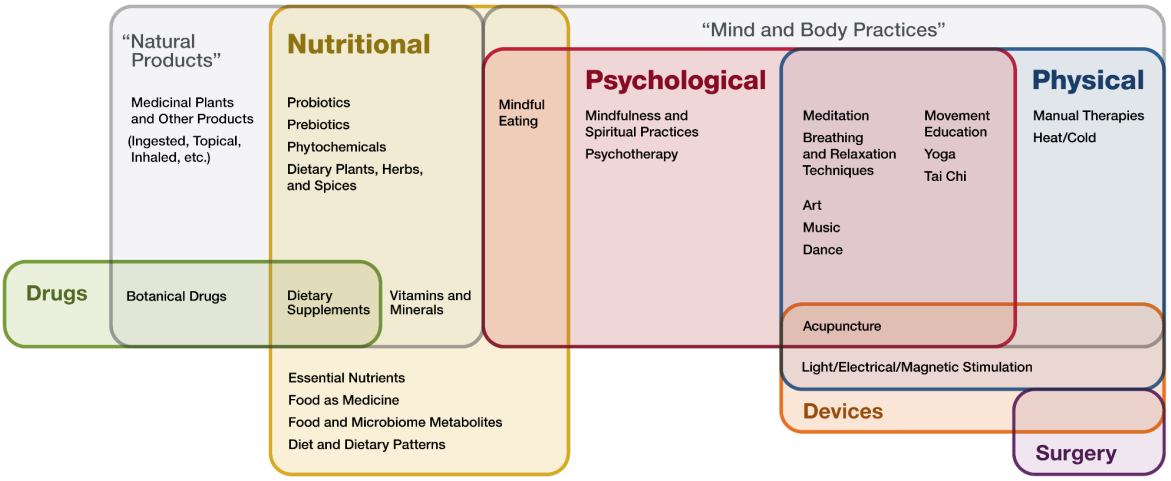
In the review by Campbell et al (2022), several factors were found to be associated with the mental health of university students. For example, a sense of belonging and a strong support system were significantly associated with mental well-being and happiness, whereas loneliness and social isolation were strongly associated with poor mental health. Similarly, characteristics such as resilience, adaptability and better coping skills were associated with mental wellbeing. Other important risk factors for poor mental health were also observed, such as previous mental illness, students on the autism spectrum, negative self-image, eating

disorders, family problems and trauma, or purely academic factors such as homework and exam pressure.

There are a variety of treatments available to take care of our mental health. In contrast to pharmacological interventions, there is a growing interest in natural therapies, which are considered to be less intrusive and more cost-effective (Robinson & Breed, 2019). For example, meditation, lifestyle changes such as increased physical activity, community activities and participation in natural environments are emerging as potential alternatives to complement or replace other forms of treatment (Robinson & Breed, 2019; Saizar & Korman, 2012). Find below a diagram of some of these health tools (Figure 1).

Figure 1

Examples of complementary health approaches



Note. Figure extracted from the National Institute for Complementary and Integrative Health (NICIH).

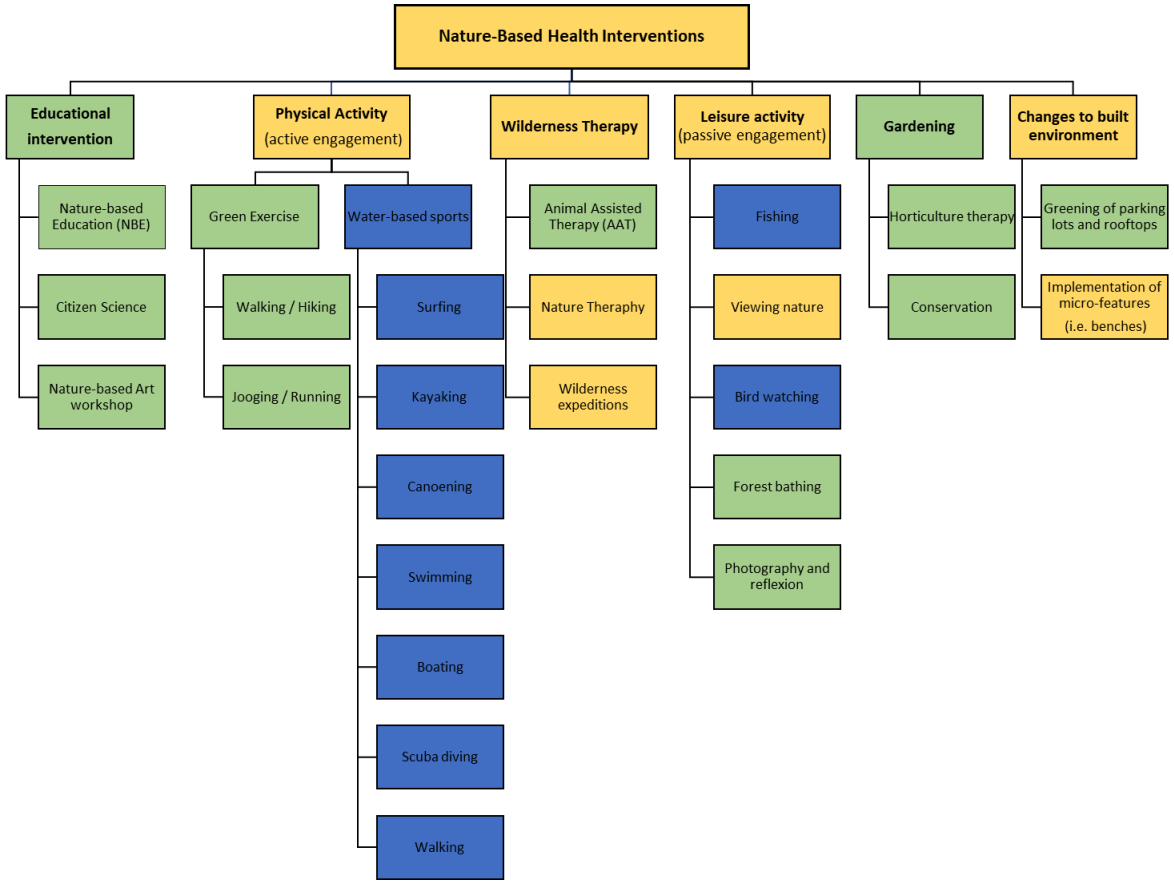
Most of these nature-based interventions (NBIs) take place in natural outdoor environments, defined as "any environment where green vegetation or blue water resources can be found", access to which is becoming more and more difficult (Kondo et al., 2020). What is more, a number of geographical, economic and cultural barriers affect how we interact with these environments and, in view of the lack of significant changes in our lifestyles, these are likely to get worse as we increasingly move away from natural spaces, and human populations become more concentrated in urban areas, where 68% of the world's population is expected to live by 2050 (Ritchie & Roser, 2018).

In a recent review (Nejade et al., 2022) six main types of NBIs were identified: educational interventions, Physical Activity (hereinafter called PA), nature therapy, leisure

activities, gardening and changes to the built environment, all of which are reflected in the figure below (Figure 2). Factors influencing engagement with the outdoor natural environment were also identified: connection to biodiversity and natural spaces, air and noise pollution, socio-economic status and associated stigma, and geographical proximity alongside opportunities for PA.

Figure 2

Nature-Based Health Interventions



Note. All types of nature-based health interventions found in the selected studies. Green–green spaces, blue–blue spaces, and yellow–both green and blue spaces. Figure adapted from Nejade et al., 2022.

These NBIs influence non-communicable diseases (NCDs), also known as chronic diseases, which are usually long-lasting conditions resulting from a combination of genetic, physiological, environmental and behavioral factors. The main types of NCDs are cardiovascular diseases, cancers, chronic respiratory diseases and diabetes.

According to the World Health Organization, NCDs are the leading cause of the global burden of disease and disproportionately affect people in low- and middle-income countries, which encompasses three-quarters of all deaths worldwide, about 41 million people

each year. To control NCDs a focus on reducing the risk factors associated with these diseases is required, particularly modifiable behaviors such as tobacco use, physical inactivity, unhealthy diets and harmful alcohol consumption, among others, which significantly increase the risk of suffering these diseases.

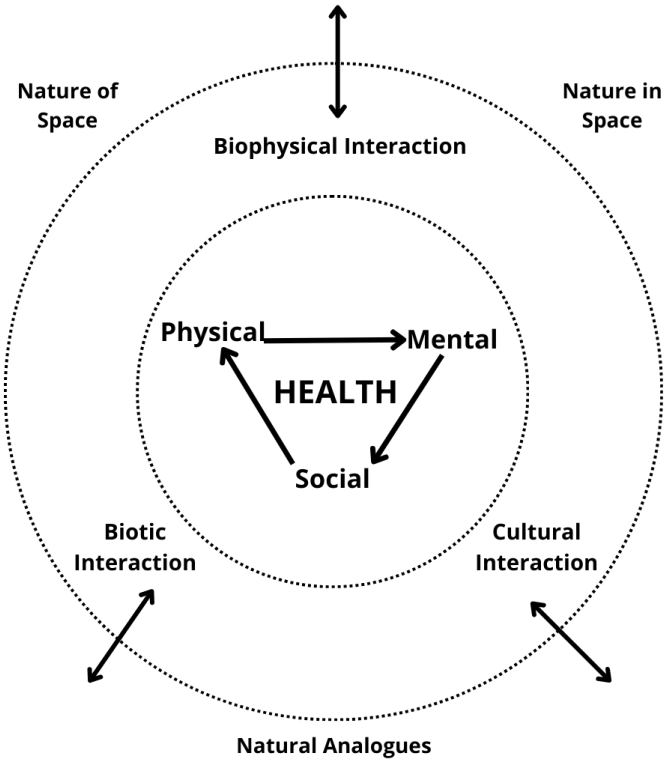
Thus, poor mental health increases the risk of developing an NCD through the adoption of unhealthy behaviors and a lack of seeking for professional help (Cohen et al., 2015; Caruso et al., 2017). While these modifiable risk factors are the main drivers of NCDs, other important determinants of health have also emerged, such as environmental exposures (Prüss-Ustün, 2019).

For all these reasons, the effects of the relationship between humans and nature on human health has increased as evidence of this nexus has grown stronger in the scientific literature, and which has been analyzed from multiple approaches. Therefore, a multidisciplinary approach between people and health ecosystems is key for an effective impact in our interventions (Seymour, 2016) (see Figure 3).

Figure 3

General vision of the connections of human-nature relationships between different fields of research and interdisciplinary perspective of human health

Research field	Type of connection	Descripción
Evolutionary biology	*Cultural–genetic interaction (coevolution)*	The interrelationship between two or more inherent systems (e.g., biophysical, biotic, and cultural). Examples used in this review related to lifestyle and dietary choices. Overlaps identified between the following research disciplines and fields: human health, genetics, evolutionary studies, culture, and social economic behaviors.
Evolutionary psychology	*Affiliation to nature*	The instinctive esthetic preference and value for nature. Examples used in this review related to people's feelings of connectedness to nature. Overlaps identified between the following research disciplines and fields: evolution, mental health and well-being, social and behavioral ecology, psychology, culture, and human development.
Social economics	*Economic–nature conflicts*	The values of nature are counter intuitive with those values and actions of capitalism. Examples used in this review related to natural resource management. Overlaps identified between the following research disciplines and fields: social economics, ecosystem accounting, power relationships, conservation and resource management, affiliation to nature, and biophysical systems.
Environmentalism	*Power relationships*	Those power relationships exerted by both nature and humanity. Examples used in this review related to conservation behaviors and management of the natural environment. Overlaps identified between the following research disciplines and fields: economic–nature conflicts, conservation management, social and cultural behaviors, social health, affiliation to nature, and biophysical systems.

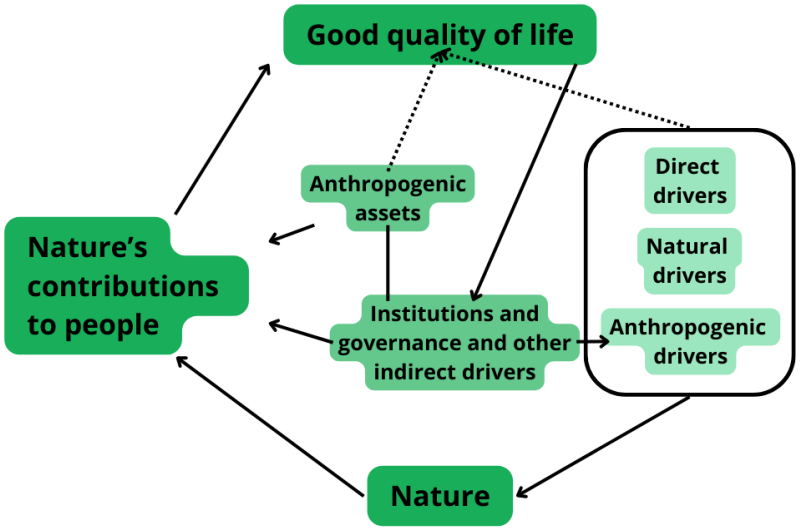


Note. Adapted from Seymour (2016).

Similarly, one of the main motivations of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is nature's contributions to people (NCPs). NCPs refer to all aspects of the impact of living nature (biological diversity, ecosystems and related ecological and evolutionary processes) on the quality of human life, both positive and negative. Broadly speaking, the NCP approach explicitly recognizes the diversity of perspectives in which humans and non-humans are intertwined in complex relationships of kinship and interdependence in which they are seen as separate from each other. Furthermore, different cultural lenses are used to understand how nature and humans together form the NCP, which can be observed from both a contextual and a generalizing perspective (Figure 4) (Díaz et al., 2018).

Figure 4

Conceptual framework of nature's contributions to people



Note. Adapted from Díaz et al. (2018).

From a more theoretical approach to the issue, the 'biophilia hypothesis' postulates that humans have evolved with nature to have an affinity with it (Gaekwad et al., 2022). Two important theories have emerged from this concept: the Attention Restoration Theory (ART) and the Stress Reduction Theory (SRT), which have led to a better understanding of the mechanisms by which spending time in nature can affect human health.

On the one hand, ART (Kaplan & Kaplan, 1989) postulates that the mental fatigue associated with modern life is related to a decrease in the ability to direct attention. According to this theory, spending time in natural environments allows people to overcome this mental fatigue and restore the ability to focus attention. ART focuses on the power of nature to restore certain types of attention through unconscious cognitive processes in response to natural landscapes. By comparing the types of stimuli that are present in natural and non-natural environments, this theory attempts to explain the differences between exposure to natural and non-natural environments. The authors claim that stimuli in natural environments (such as leaves and grass) attract moderate attention, whereas stimuli in urban centers (such as flashing advertisements and noise) attract a lot of attention (distract) and therefore observers use more resources to ignore them.

The authors point out that being in nature can reduce stress and improve mood and productivity precisely because the stimuli in natural environments allow attention to shift easily from one to another without fatiguing the observer. However, to achieve these

restorative benefits of nature, the displayed environment must be compatible with the observer's preferences.

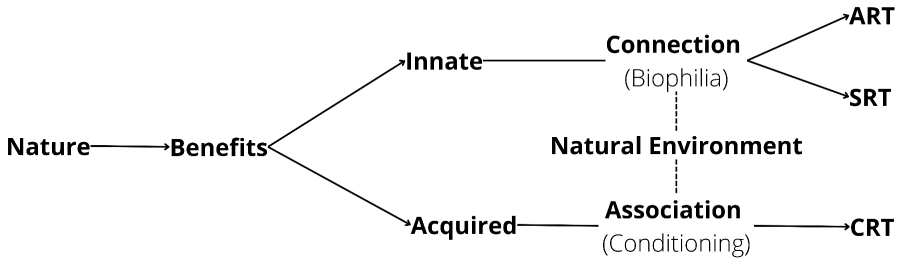
On the other hand, the SRT (Ulrich, 1993) describes how spending time in nature can influence feelings or emotions by activating the parasympathetic nervous system to reduce stress and autonomic arousal due to people's innate connection to the natural world. Ulrich suggests that the initial response of a human being to a fusion with nature may be emotional rather than cognitive, and that it may be the structural properties of the environment (e.g. the location and grouping of objects) that trigger an automatic emotional response in the human being. Thus, stimuli that are atypical are perceived as threatening, resulting in physiological arousal. In this way, this theory suggests that the healing power of nature lies in an unconscious and autonomous response to the elements of nature.

Knowing that natural stimuli can quickly induce positive emotions and reduce physiological agitation and negative thoughts, SRT focuses on promoting psychophysiological stress reduction. Correspondingly, ART emphasizes the role of nature in the restoration of functional capacity, suggesting that the natural environment can restore limited cognitive resources (in particular attention) that have been depleted by excessive use.

According to these psycho-evolutionary theories, humans have an innate preference for natural environments that provide safety and resources for survival. They also suggest why being in these environments is associated with greater well-being and fewer negative emotions. Finally, on the counterpart, Egner et al. (2020) present the Conditioned Restoration Theory (CRT), which suggests that nature does not have such anti-stress properties *per se*, but functions as a relaxing environment because of the mental association that has been created with it through personal and social multicausality. A schematic diagram (Figure 5) is presented below to illustrate these theories.

Figure 5

Theories about the benefits of the contact with nature



Note. Elaboration by the Author.

Based on these theories, there have been numerous studies that have attempted to demonstrate the relationship between our health and the environment. For example, the *literature review* (Jiménez et al., 2021) shows the multiple benefits associated between CN and health, such as: reduction of stress, improvement of mood, reduction of anxiety, ruminative and depressive states, improvement of cognitive function (attention, executive function and recovery capacity), increase in brain activity in regulating emotions, reduction of blood pressure, increase in immune system function and improvement in post-operative recovery, among others. Below is a visual layout (Figure 6) of the effects found in this research.

Figure 6

Effects of contact with nature on health

EFFECTS OF CONTACT WITH NATURE ON HEALTH	**Mental Health**	Stress reduction
		Mood improvement
		Reduction of anxiety, ruminative and depressive state
		Increased brain activity in the regulation of emotions
		Improved cognitive function (Attention, Executive Function and Restoration Capacity)
	Physical Health	Lowering blood pressure
		Increased immune system function
		Improved postoperative recovery
	Growth Development	Positive birth effects (Lower risk of low birth weight)
		Improved mental well-being, general health and cognitive development of children
	Physical Activity	Promotion of physical activity
		Influence on overweight or obesity (Lower risk of being overweight)
	Sleep	Greater duration and quality.
	Prevention	Lower risk of suffering from cardiovascular diseases
		Type II diabetes
		Protective function against various types of cancer
		Reduced mortality
		Protection against inflammatory diseases (asthma, allergies)

Note. Elaboration by the Author based on information from Jiménez et al., 2021.

Following the same line of research, several observational studies have shown a strong positive correlation between exposure to urban GSs and physical and emotional health (Bratman et al., 2012). Environmental conditions can be interpreted as background factors of stress-related mechanisms that mediate between environment and health. These mechanisms

can act as an environmental stressor of human adaptation or as a coping strategy, restoring some balance between environmental demands and personal resources (Berto, 2014).

There is evidence that recovery from stress and mental fatigue is related to CN, as natural environments protect people from environmental stressors and provide greater physiological, emotional and attentional recovery than urban environments (Hartig et al., 2003; Ulrich et al., 1991). These natural places that allow a shift towards more positive states of emotional and physiological activity, as well as behavioral and cognitive functioning, are referred to as 'restorative environments' (Kaplan & Kaplan, 1989; Kaplan, 1995). Therefore, environmental preferences are influenced by this restorative need of people, and environments perceived as natural tend to be more restorative than those perceived as urban or artificial (Hidalgo et al., 2006; Van den Berg et al., 2003; Weber & Trojan, 2018). In addition, CN is also associated with positive effects on body image, a complex construct that incorporates thoughts, feelings, beliefs, and actions related to the body (Bailey et al., 2017) and state of happiness (Stieger et al., 2022).

Everything that has been presented in this section shows us how CN implies an increase in connection with it, and this connection acts as *a mediator between this contact and well-being itself* (Mayer et al., 2009). In this respect, to study the connection with the natural environment tools such as the Connectedness to Nature Scale (CNS) are available, which is used to measure the cognitive component of the bond between people and nature (Pasca & Coello, 2017), or the Love and Care for Nature (LCN) scale, which measures the emotional component of the connection (Perkins, 2010).

The aforementioned tools have been useful, above all, in expressing that CN promotes positive affection in people, as well as their connection with nature (Pasca & Aragonés, 2021). A positive relationship has also been found between individual experiences of connection with nature and life satisfaction and high self-esteem (Zhang et al., 2014); the same happens with psychological well-being (Cervinka et al., 2012) and anxiety (Martyn & Brymer, 2016). It is worth mentioning that urban areas show lower levels of connection with nature (Braito et al., 2017).

In academia, educational achievement has been correlated with exposure to natural spaces (Browning & Rigolon, 2019). For example, the amount of vegetation in or around academic courtyards has been found to be favorably correlated with students' academic performance (Li et al., 2019). What is more, there is also evidence that being surrounded by vegetation can improve students' attention span and help them recover from stress and mental fatigue (Li & Sullivan, 2016; Van den Berg et al., 2017).

Similarly, these benefits of CN can also occur when CN is delivered through a single sensory stimulus channel. For example, visual exposure to natural elements can improve college students' ability to recover attention (Lee et al., 2015), while natural sounds can improve college students' academic performance (Luo et al., 2022) and psychological well-being (Ratcliffe, 2021).

At the level of connection with nature, results have shown that students living in rural areas report lower levels of connection with nature. In contrast, a higher percentage of weekly time spent in nature and participation in outdoor activities are socio-demographic factors that predict urban nature connectedness (Schönbach et al., 2022). Similarly, higher preferences for outdoor recreation have been observed to be associated with higher levels of environmental connection among university students, with the female gender reporting higher levels of connectedness (Rosa et al., 2023) and ethnicity playing a differentiating role in terms of received perceptions of nature (Taylor, 2019). Therefore, taking into account the health issues of university students and the benefits of nature, the implementation of NBIs is crucial for improving the well-being of students (Rakow & Ibes, 2022).

It has been shown that CN improves our quality of life (Diaz et al., 2018). For example, a meta-analysis by Capaldi et al. (2014) investigated the association between happiness and connection to nature and found that, statistically speaking, the effect sizes were significant. In particular, associations were found between nature connectedness and vitality, happiness and life satisfaction.

Furthermore, Pritchard and collaborators (2020) demonstrated the relationship between nature connectedness and eudaimonic well-being, which was not different from hedonic well-being, being personal growth the strongest component of this relationship. Similarly, it should be highlighted that a significant predictor of this natural connection is the activity of interacting with nature itself (Lumber et al., 2017).

However, as more people live in urban areas and spend most of their time indoors, CN is decreasing (Frumkin et al., 2017). Spending too much time in front of screens, a trend that is increasing, especially among young people, only exacerbates the problem (Vizcaino et al., 2019).

Young adults also face a number of life-changing challenges, especially university students. Among the most common stresses are those related to academic achievement, such anxiety before exams, pressure to excel, interpersonal relationships, and concerns about what to do next after graduation (Beiter et al., 2015).

To improve the relationship between nature and college students, Sharma et al. (2020) used the multi-theory model (MTM) of health behavior change as the framework for their study to explain the relationship between CN and university students. This approach divides behavior change into two stages: (1) initiation and (2) sustenance or maintenance.

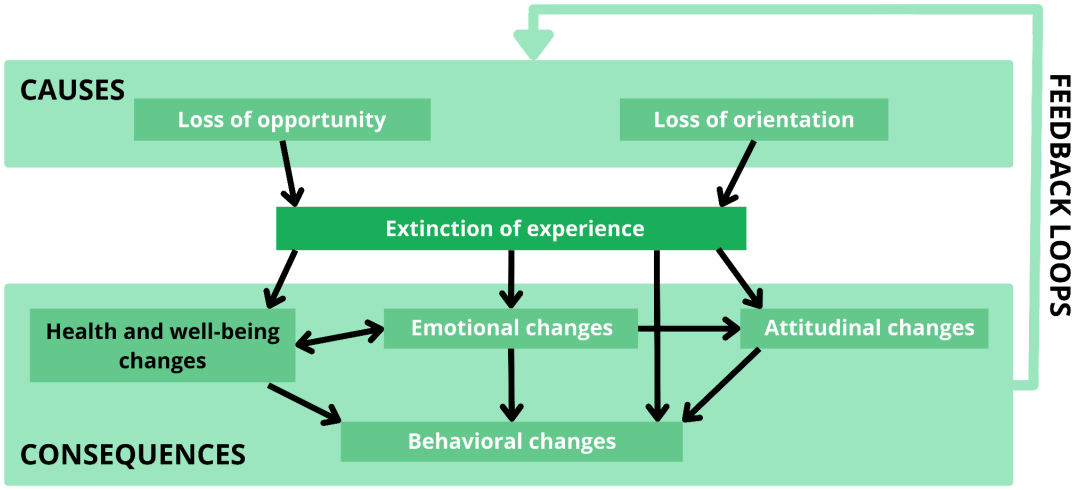
For initiation, the person must be convinced that the benefits outweigh the disadvantages (participatory dialogue), show confidence in the behavior and have the support of the environment. And to maintain the change in behavior, the person must be able to channel their emotions and turn them into goals, constantly strive for change (practice for change) and have the support of their social environment (Dokun-Mowete et al., 2019).

The research highlighted how the three constructs of this model, concretely emotional transformation, practice for change and changes in the social environment, contributed significantly in the subjects' behavior. Thus, the MTM could become a useful and practical framework for designing interventions to promote CN behavior in university students.

As shown, there is growing evidence that CN improves the health and well-being of adults and children (Twohig-Bennett & Jones, 2018). At the same time, young people are living a more sedentary, urban and technology-centered life, and the frequency with which they have outdoor encounters and daily connections with nature is decreasing (Soga & Gaston, 2016). One of the main causes of this loss of interactions is reduced opportunities to directly experience nature (Figure 7).

Figure 7

Causes and consequences of the extinction of experience with nature



Note. The extinction of experience can lead to a feedback loop in which the consequences accelerate the loss of interactions with nature (Translated and adapted from Soga & Gaston (2016).

Similarly, individuals who participate in outdoor recreation as children are more likely to do so as adults (Taye et al., 2019). For example, McMahan & Estes (2015) suggest that CN may help to satisfy university students' need for exploration and help them to gain a broader perspective on their place in the environment and their tasks. However, it is not yet fully understood how small changes, such as those from adolescence to emerging adulthood, affect participation in outdoor activities (Lovelock et al., 2016).

Returning to the student environment, studies in university areas have shown a correlation between use and increased access to GSs and improved quality of life (Van den Bogerd et al., 2020). Furthermore, according to Birch et al. (2020), natural interactions provide urban youth with a stronger and more authentic sense of who they are, or a different perspective on their place in the world. Similarly, Nisbet et al. (2011) observed how those university students who took environmental courses were able to maintain their connection to nature and, consequently, their energy throughout the academic year and under less favorable conditions. In terms of academic skills, performance, concentration and the ability to complete mentally demanding tasks are enhanced by CN, be that either in urban or natural environments (Bratman et al., 2015; Van den Berg et al., 2003).

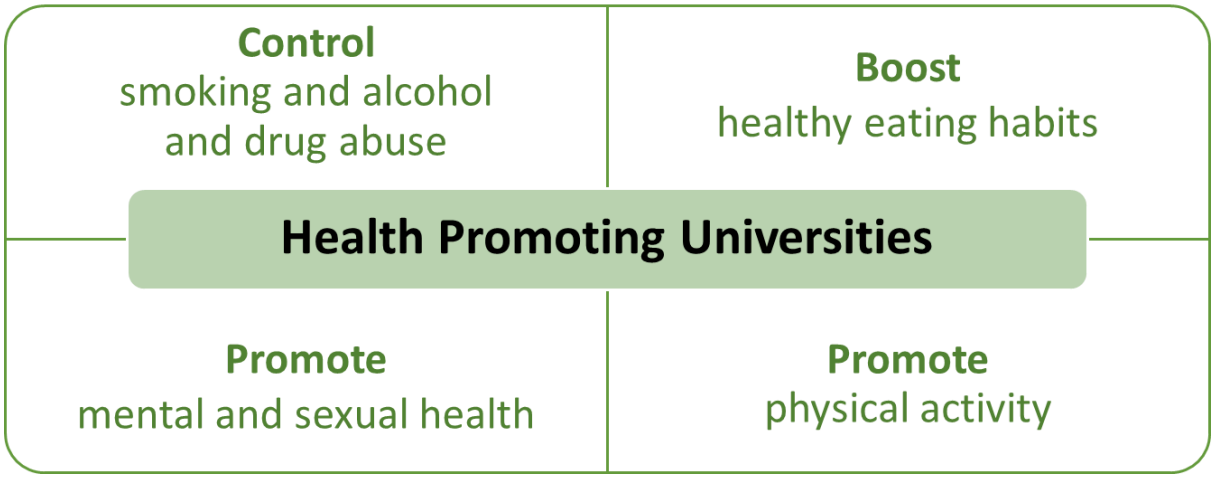
2.1.2. Contact with Nature and Physical Activity

University students need to make changes in their lifestyles, as sedentary and unhealthy lifestyles are reported wherever research is conducted (Peltzer et al., 2014). Therefore, there is a need to provide PA and health promotion strategies, a concept known as Health Promoting Universities (HPUs).

The objectives of an HPU are (a) promote and plan healthy and sustainable policies across the university, (b) provide a healthy working environment, (c) support the personal health and social development of the people involved, (d) establish and enhance primary health care, (e) ensure a healthy and sustainable physical environment, (f) foster wider academic interest in health promotion, and (g) develop relationships with the community (Dooris, 2002). Tafireyi & Grace (2022) also conducted a review of this type of health promotion and found the key areas of HPUs, shown in the following figure (Figure 8).

Figure 8

Key areas of the Health Promoting Universities



Note. Elaboration by the Author based on information from Tafireyi & Grace (2022).

The consequences of these sedentary behaviors, including overweight and obesity, are important causes of chronic diseases and illnesses (Labree et al., 2015). Physical inactivity and sedentary lifestyles can lead to overweight and obesity (Awosan et al., 2014), highlighting the need for a healthy lifestyle, which means practicing PA. The reason behind this is that PA has numerous benefits, including reducing stress and anxiety, increasing happiness chemicals, improving self-esteem and self-image, improving muscles, bones and strength, and preventing NCDs (Abou, 2016).

Similarly, a negative relationship has been found between PA levels and alcohol and tobacco consumption, showing benefits at physical, psychological and social levels (Donoghue et al., 2017; Lewis, 2017). Furthermore, when these benefits are put together in the context of nature, it has been found that practicing PA in a natural environment has significant pleasurable effects that involve interacting with nature in new environments, while being characterized by less strict rules compared to more competitive sports (Lawton et al., 2017).

Therefore, activities in natural settings appear to be an ideal way to learn about and enjoy the environment while engaging in motor activities that provide physical, cognitive and social benefits. This happens because natural environments have characteristics that make them conducive to enjoyment, thus enhancing the hedonic component of sport (Lorenz et al., 2017).

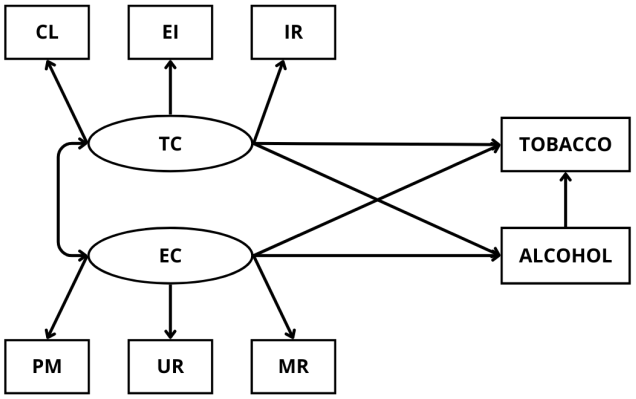
Similarly, several studies have identified benefits derived from the practice of PA in nature, such as reduced cardiovascular disease, reduced rates of overweight and obesity,

preventive effects against type 2 diabetes, various psychosocial benefits such as reduced levels of anxiety, of depression, of stress and also of emotional distress (Casper & Pfahl, 2015; Cox et al., 2017; Gómez et al., 2018; Moreno et al., 2015).

From a more psychological approach, professionals in the field consider motivation to be one of the most influential factors to explain human behavior (Gutiérrez, M., & López, 2012). The importance of motivation in people's daily lives lies in its influence to perform or not to perform certain behaviors, providing a theoretical basis for understanding human behavior (Ryan & Deci, 2017). In the case of PA and sport, there are a variety of psychological and behavioral factors related to its practice (Dweck, 1986). To understand these exposed relationships, Castro-Sánchez et al. (2019) created an explanatory model (Figure 9) of the motivational climate in sport, considering its possible influence on alcohol and tobacco consumption with a database of more than 11,000 students.

Figure 9

Multi-group structural equation modeling about motivation and harmful habits



Note. TC: Task Climate; CL: Task Climate Cooperative Learning; EI: Effort/Improvement in Task Climate; IR: Important Role in Task Climate; EC: Ego Climate; MR: Rivalry among Team Members in Ego Climate; UR: Unequal Recognition in Ego Climate; PM: Punishment for Errors in Ego Climate; TOBACCO: Tobacco Consumption; ALCOHOL: Alcohol Consumption. Elaboration by the Author and adapted from Castro-Sánchez et al. (2019).

The proposed model showed that individuals who practiced PA in a natural environment perceived a high level of task involvement and a low level of ego involvement, in contrast to the perceptions of those who practiced it in other environments. This suggests that PA in nature has a recreational component that favors strong motivation and thus becomes a crucial factor for adherence to PA practice itself, as well as it is an element that favors lower consumption of harmful substances.

In this sense and given the current evidence, it is clear that being exposed to CN improves well-being and health (Bowler et al., 2010; Pasanen et al., 2014; Shanahan et al., 2016). What is more, if it is added the component of exercise, it is found that performing PA in nature has been associated with improved mood (Hartig et al., 2003), improvements in attention (Berman et al., 2008) and cognitive ability (Berman et al., 2012), where it has also been found to provide greater psychological benefits compared to PA practiced indoors (Passmore & Howell, 2014; Lawton et al., 2017).

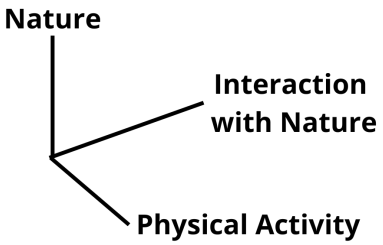
Therefore, given that PA and CN promote individual health and well-being, it is necessary to assess the importance of exercising in natural environments as a potential synergy between the two (Pretty et al., 2005). This is due to the fact that there is evidence of higher levels of satisfaction when engaging in PA in natural environments (Lahart et al., 2019), environments which provide inspiration for exercise, which improves fitness and health, as well as emotional well-being (Shanahan et al., 2016).

This fusion of concepts is scientifically known as Green Exercise (GE). GE could be defined as PA or exercise practiced in environments with a higher proportion of natural elements to artificial ones than to which can usually be found in everyday life; this concept covers all types of PA performed in open spaces such as parks, public squares, sports fields, forests or farmland (Han & Wang, 2018).

GE can be divided into three levels according to the degree of interaction with nature (Han, 2021). We would start with the observation of the natural environment in the first level, even through a photograph; then, in the second level, we would continue with the actual stay in nature, which would include activities such as walking or cycling in nature; and finally, in the third level, we would include activities with a more active participation and engagement with such environments, such as gardening or camping (Han & Wang, 2018); all this provides us with a three-dimensional framework on GE (Figure 10).

Figure 10

Frame of the Green Exercise



Note. Frame extracted from Han & Wang (2018).

On an academic level, a study by Holt et al. (2019) found that university students who regularly engaged in PA outdoors reported higher quality of life, happier emotions, and less perceived stress. Furthermore, according to Wolsko and Lindberg (2013), university students who participated in more recreational outdoor activities were more likely to feel a deeper connection to nature and proved to enjoy greater psychological well-being. In this sense, walking outdoors is an activity that can improve directed attention abilities which can be assessed through the completion of tasks (Berman et al., 2008).

Therefore, university students need to be able to overcome the intrapersonal, interpersonal as well as structural barriers to perform outdoor leisure activities related to lack of time, personal motivation, energy or companionship and spatial alienation so as to be able to benefit from the effects CN has to offer (Holt et al., 2019; Lovelock et al., 2016).

Finally, natural environments offer a wide range of leisure activities and social gatherings to enjoy with friends and family. The latter's interaction with nature has a holistic impact on human well-being, providing opportunities for PA, emotional and cognitive regeneration, self-reflection and social relationship building, besides reducing the harmful physiological effects of various stressors. Therefore, it must be highlighted the importance of including young adults' perspectives in land-use planning and decision-making in order to provide a variety of opportunities for nature-based outdoor recreation and tourism (Puhakka, 2021).

2.2. Green Spaces

2.2.1. Green Spaces and Health

Broadly speaking, the health effects of GSs and blue spaces (public outdoor spaces that incorporate water bodies in their landscape setting) can be summarized in three main biopsychosocial pathways, harm reduction (capturing and limiting air pollution, noise and heat), capacity restoration (attention recovery and stress reduction) and capacity building (improved PA and social cohesion) (Wolch et al., 2014; Lee & Maheswaran, 2011; Nieuwenhuijsen et al., 2017; Maas et al., 2009; Van den Berg, 2019).

Maas et al. (2019) conducted a study on morbidity in primary health care where they deduced that, in general, having a 10% more of green space than the average in the surrounding environment is associated with a lower risk of mental and physical disorders; also this relationship turned out to be stronger when the green space was within a distance of

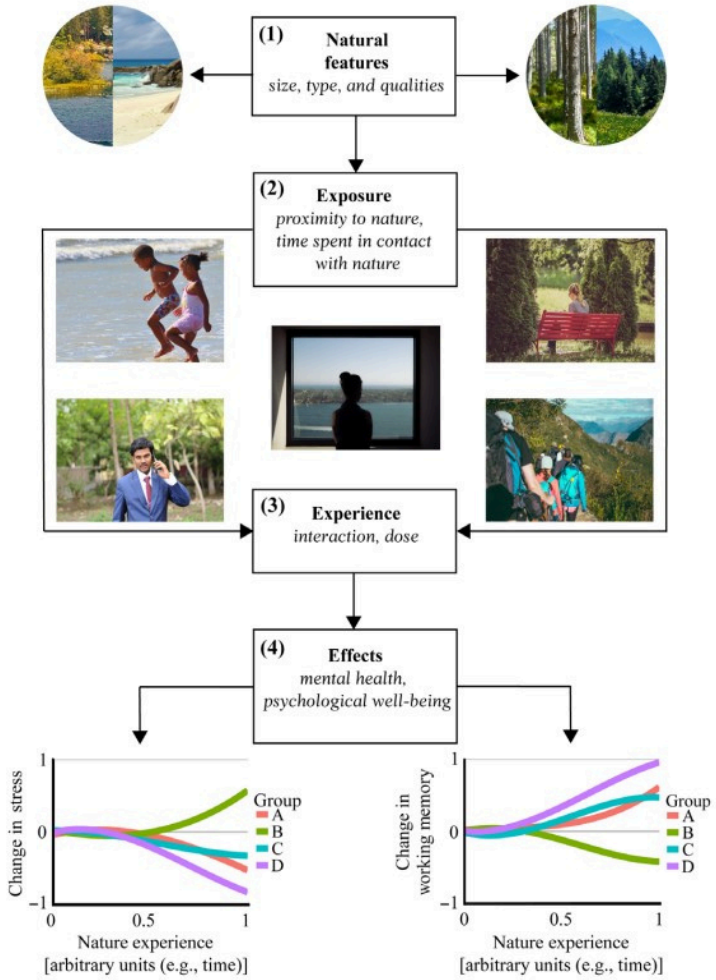
1 km versus 3 km. Several studies have also shown that the benefits of GSs are bigger for people of lower socioeconomic status, of non-white ethnicity and for the male gender (Maas et al., 2019; Roe et al., 2016; Richardson & Mitchell, 2010). In addition, the Normalised Difference Vegetation Index (NDVI) is the most commonly used indicator to measure the amount of green space, followed by the percentage of GSs (Geneshka et al., 2021).

Many of the contributions of living nature (the diversity of organisms, ecosystems and their processes) to the quality of human life can be described as 'ecosystem services'. These include water purification, food provision, climate stabilization, flood protection, among many others (MEA, 2015). Global efforts are underway to incorporate these ecosystem services and their values into policy, finance and management (Li et al., 2015; Guerry, 2015). These efforts are increasingly based on models that link ecosystem change to changes in provision of services, which are being adopted internationally (Kareiva et al., 2011).

In this sense, there is a clear demand from practitioners and decision-makers to incorporate these models in order to analyze a range of social conditions, such as effects of nature on mental health and nature in the evaluation and policy of ecosystem services. Building on this foundation, Bratman et al. (2019) propose a conceptual model of mental health impacts derived from the CN experience, shown in Figure 11.

Figure 11

Conceptual model of mental health as an ecosystem service



Note. Model extracted from Bratman et al. (2019).

This example, among others, illustrates how these tools provide opportunities to make and refine predictions about the impact of health factors and CN through a priori estimates based on emerging evidence. In the same way, they also act as a means of testing predictions by observing changes over time in real-world contexts. A range of stakeholders, including urban planners, landscape architects, engineers, park departments, developers, infrastructure providers, health professionals, community organizations and environmental advocates, could use such tools to help them anticipate health impacts on citizens when making decisions about the environment.

For all this, there is a fundamental key, which is the collection of data and research in this area, without forgetting the existing inequalities when it comes to the access to digital health and its derivatives (WHO, 2022).

In this sense, a well-designed urban landscape can contribute to a less stressful day (Chang et al., 2021; Grahn, P., & Stigsdotter, U.A. (2003)) and provide an opportunity for physical, cognitive and emotional recovery (Abdulkarim & Nasar, 2014). We have seen in the previous example (Figure 9) that technology and nature can go hand in hand to create new improvements in our society; this is where the concept known as "technobiophilia" finds its origin, and which refers to the innate tendency to focus on life and life processes as they appear in technology. This concept is an extrapolation of the biophilia hypothesis, whose artifacts and/or practices are characterized by one or more of the following factors: (a) a connection between life in nature and life in the digital world, (b) an enhancement of well-being through a balance between technology and nature, and (c) a support for future biodiversity through the proximity of technology and nature (Thomas, 2013).

Such applications of technobiophilia focus on finding solutions to current problems, such as urban development (Beatley, 2016) or taking action on climate change (Stefanakis et al., 2021). What is more, through awareness and behavior change, technobiophilia is based on the involvement of financial institutions and public sector initiatives and aims to contribute to the realization of financial frameworks to solve challenges at community, regional, national and global scales (Jacobs, 2021; Wyns & Beagley, 2021). Its objectives for the future are to improve environmental issues and to increasingly reinforce the relationship between nature and technology (Hiroko et al., 2022).

Urban green spaces can also entail economic, psychosocial and physical risks, such as 'green gentrification'. Such a phenomenon can follow the provision of amenities such as parks and trails, increasing property values and causing the displacement of established low-income communities. Therefore, distributing and making a good use of these green spaces is essential (Cole et al., 2019; Rigolon et al., 2020), even more so given that urban areas represent more than half of the world's population and are expected to absorb population growth over the next three decades, according to a UN report (2018).

For all these reasons, cities are appropriate units of analysis because they are discrete entities. They are social and physical ecosystems in which exposure to GSs may be comparatively limited but particularly valuable. In addition, cities also tend to be planning units and thus targets for the application of knowledge about nature and health (Hall, 1996).

Therefore, urban planning and design can alter the health environments of large numbers of people, making cities an ideal unit of analysis for studying the relationship between environmental exposure and public health. This is because it covers the daily displacement of people and also the existing positive association between GSs and all types

of mortality (Richardson et al., 2012). This occurs even more so when assessing the restorative function of these GSs, as it can be argued that each person will have different experiences and effects of public green spaces, such as botanical gardens (Carrus et al., 2017).

It should not either be forgotten one of the places where students spend most of their academic lives: the universities themselves. The university campus is the setting for many young adults' experiences of higher education, independent living and living away from parents. Depending on the type of campus, opportunities and experiences with GSs will vary greatly, therefore it is important to approach the transition to university life holistically and understand how the environment and curriculum affect students' well-being (Cage et al., 2021).

The potential of university campuses to exert a healthy influence has been highlighted in recent research on the relationship between nature and well-being. This happens because natural spaces provide respite for university students and are a factor in student retention (Windhorst & Williams, 2015). For example, in the aforementioned study, students preferred environments that provided a respite from the pressures of everyday life. This study also found that the absence of social interaction in the environment was significant, and that spending time in natural environments allowed participants to escape from the perceived social pressures and social judgements of academic life.

Furthermore, student happiness and campus resilience are associated with the GSs available on campuses, which provide students with respite during difficult life transitions that occur at university (Hipp et al., 2016). The reason behind this is that academic success is linked to students' experiences on university campuses, both in and out of the classroom (Felsten, 2009; Lu & Fu, 2019).

For all these reasons, practitioners and decision-makers must take into account the needs of university students for GSs on campus. These actions become an essential requirement for the implementation of behavioral changes in the creation of places that will be used by the target group, and whose policy and practical implications are particularly related to the use and development of NBIs for university students in the context of academic institutions (Boyd, 2022).

2.2.2. Green Spaces and Physical Activity

The use of public spaces for outdoor PA is essential, especially in cities. This has been demonstrated in times of health crises, such as the recent COVID-19 pandemic (Venter, 2020; Noël & Dardenne, 2022).

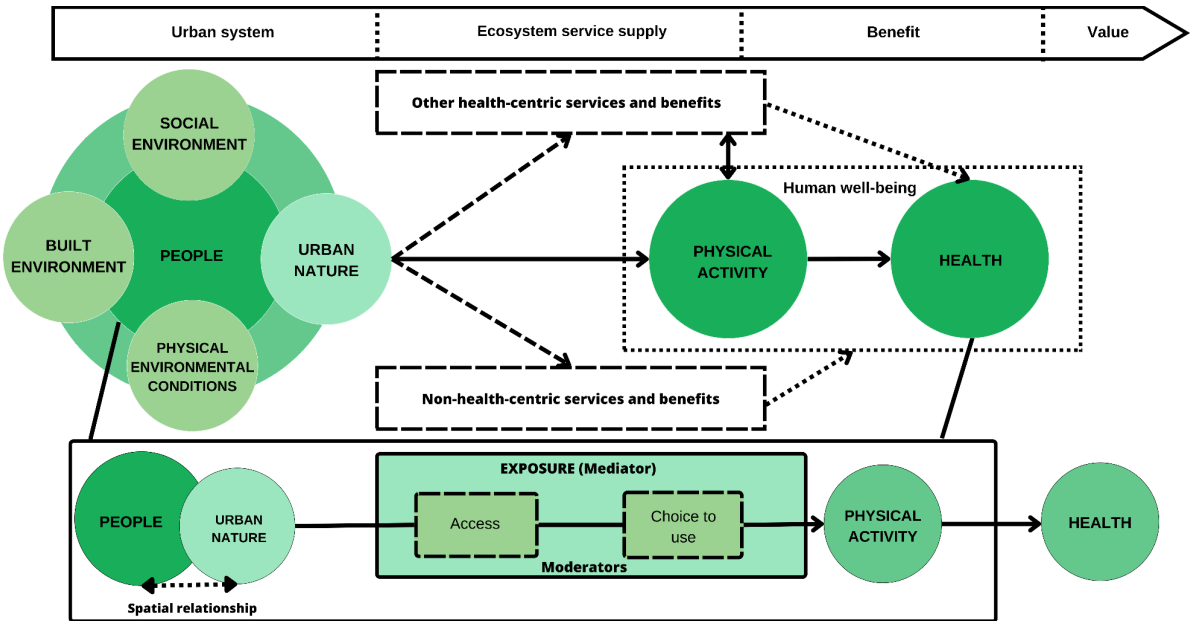
Lack of PA is a major risk factor for morbidity and premature mortality worldwide, with physical inactivity accounting for at least 6% of global premature mortality, and 1.4 billion adults being at risk of developing or exacerbating inactivity-related diseases (Guthold et al., 2018; Strain et al., 2020).

As discussed above, nature positively influences human health in a number of ways. One widely recognised way is by providing opportunities for PA practice (Hartig et al., 2014; James et al., 2015), in which both the quantity and quality of natural elements play an important role (Sallis et al., 2016; Shanahan et al., 2016; Schipperijn et al., 2017). In this framework, there is evidence of associations between PA levels and GSs (Barton & Pretty, 2010; Pretty et al., 2005).

In an effort to integrate the science of nature in and around cities, PA and health with an ecosystem services approach, Remme et al. (2021) developed a broadly applicable model framework to support decision-making. Such a framework focused on planning and managing urban nature through its multifunctionality (Guerry et al., 2015; IPBES, 2019) so as to contribute to its assessment, as it introduces spatially explicit nature-related health outcomes into broader health assessment frameworks (Figure 12).

Figure 12

Conceptual model of the relationships between urban nature, physical activity and health



Note. Adapted by the Author from the model of Remme et al. (2021).

This model serves as an appropriate complement to existing health and nature approaches and tools (Bratman et al., 2019; Oosterbroek et al., 2016), providing relevant information for broader health assessments. Such a tool can be integrated with urban nature models that quantify urban ecosystem services (Keeler et al., 2019; Hamel et al., 2021). The aim is for urban residents to have accessible and attractive outdoor spaces with different elements of nature that support active lifestyles in order to improve people's health by promoting PA (Remme et al., 2021).

In a monetary framework, the cost of poor mental health to the global economy is estimated to reach $16 trillion by 2030 (Patel et al., 2018). Accumulating evidence suggests that PA can be as effective as psychological and pharmacological treatments for depression and anxiety (Cooney et al., 2013; Stubbs et al., 2017).

The influence of the setting in which PA is performed on mental health outcomes has also attracted considerable interest in recent years. It has been investigated whether performing PA in natural environments, previously referred to as GE, may have better effects on mental well-being than performing PA in artificial environments such as indoor gyms (Pretty et al., 2005). Thompson Coon et al (2011) found that people had stronger feelings of freshness and positivity, less stress, confusion, anger and depression, and more energy after practicing PA outdoors in nature than indoors. Similarly, a review by Bowler et al (2010)

examined the effects of exercise in natural versus artificial environments, where artificial environments were defined as indoor spaces and unvegetated outdoor spaces. The authors found that the natural environment had a greater effect on reducing anger, fatigue and sadness and promoting calmness, as well as a slightly positive effect on energy levels. In addition to all of this, there is a growing awareness of the potential negative psychological health consequences of urban living (Gruebner et al., 2017).

In terms of gender differences, Hassmen (1996) found that women had a lower perceived exertion than what it would have been expected from their heart rate when running outdoors, whereas men had a higher perceived exertion. Barton and Pretty (2010) found that men had slightly greater improvements in mood after GE than women.

There is also evidence that men and women have different attitudes and behaviors towards nature. Puett et al. (2014) found that men are more likely to engage in outdoor physical activity, while Zelezny et al. (2000) reported that women tend to engage in more proenvironmental behaviors and feel more connected to nature. This may indicate that women may benefit more from GE in terms of psychological well-being, as connection to nature is a potential link between nature and health (Cervinka et al., 2012), and women maintain a stronger relationship with nature than men (Kaplan et al., 2021; Keith et al., 2021).

As it has been seen, physical activity in outdoor environments offers numerous social benefits and benefits to manage our mental health. Unlike gym fees, these environments are usually free and accessible to all local residents. However, previous studies have only compared the benefits of outdoor PA and not indoor PA, and it remains unclear whether the specific characteristics of an outdoor environment, regardless of whether it is 'green' or 'urban', have any effect on the benefits of outdoor exercise.

Therefore, Wicks et al (2022) conducted a systematic review with the aim of answering the above question, having as a secondary aim investigating the possible moderating role of gender, as previous studies have suggested that there may be an association between gender and the influence of the environment on the relationship between PA and mental health outcomes. This research found significant benefits of exercise in a natural environment for anxiety, depression, anger, hostility, positive affect and engagement, and energy, with the duration of PA favoring short sessions and social context as moderators of the effects.

It is widely recognized that individual behavior plays an important role in a range of environmental issues, such as pollution and biodiversity loss (Lange & Dewitte, 2019).

Therefore, it is important for individuals to adopt environmentally friendly behaviors in order to build more sustainable communities (Byerly et al., 2018).

A growing body of research suggests that being in natural environments leads to more sustainable behaviors (Martin et al., 2020; DeVille et al., 2021) and improved health and well-being (White et al., 2019; Labib et al., 2020; Bratman et al., 2019; Frumkin et al., 2017). Although CN alone may not be sufficient to achieve these potential environmental benefits, connection to the natural environment has been found to trigger greater engagement in such sustainable behaviors (Mackay & Schmitt, 2019; Pritchard et al., 2020).

Regarding the role of PA in promoting environmentally sustainable behaviors, physical activity not only promotes health, but also contributes to efforts to address climate change (Salvo et al., 2021). As noted by Abu-Omar et al. (2020), there are several links between promoting PA and reducing the impact of climate change, such as promoting active transport, the use of GSs, and the use of recreational or fitness facilities. In addition, designing infrastructure that makes it easier to walk or cycle instead of driving can reduce greenhouse gas emissions and noise pollution, improve air quality, and create healthier and more sustainable communities (Alp et al., 2006; Liu, et al., 2019).

Similarly, at the personal level, gender differences have also been observed. For example, men with higher levels of PA have been found to prefer more active modes of transport, such as walking or cycling, just as two or three weekly visits to nature have been shown to be positively associated with such sustainable behaviors (Teixera et al., 2023).

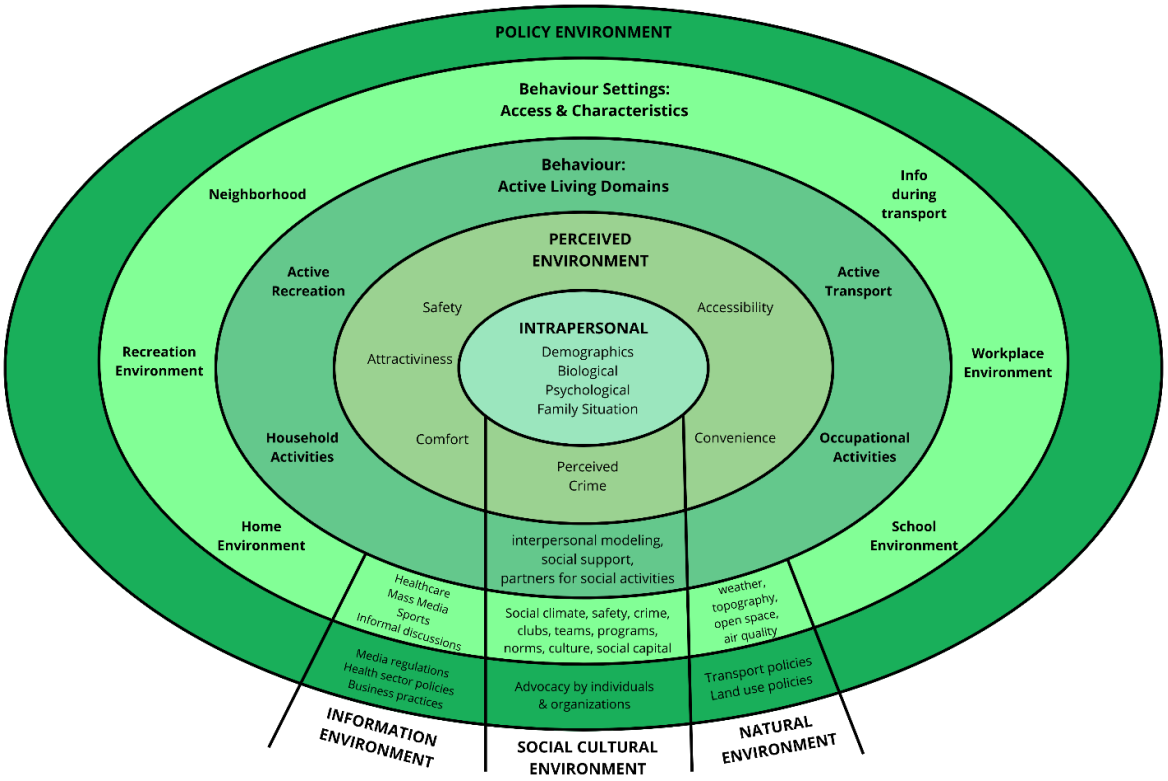
Research has shown that PA practice in natural settings is associated to more favorable health outcomes, such as blood pressure, heart rate (Duncan et al., 2014), general health (Apkinar, 2017), mental health, and cognitive development in children and teenagers (Barton & Pretty, 2010; McCormick, 2017). In addition, studies have found that GE can foster self-discipline, improve attention, memory, and social support, increase feelings of competence, reduce stress, and promote positive behaviors, while reducing risky behaviors (McCormick, 2017; Tesler et al., 2018).

GSs possess basic characteristics that either encourage or hinder GE. Akpınar (2019) observed how greater distance from urban GSs was negatively associated with the frequency of GE performed by teenagers, which is reflected by the available evidence (Zhang et al., 2019): distance alongside other limitations such as lack of activity parks or unattractive GSs (Akpınar, 2020) make people not exploit such areas to promote GE; for example, in Coombes et al. (2010) respondents living farther away from urban GSs were less likely to visit them than those living nearby. Sallis et al. (2006) identified multiple determinants of PA and active

lifestyle and grouped them into a socioecological model including primary domains such as policy, environment, interindividual elements, and intrapersonal characteristics (Figure 13).

Figure 13

Social-ecological model about determining factors of an active lifestyle



Note. Adapted by the Author from the model of Sallis et al. (2006).

The WHO also highlighted the importance of urban GSs in 2017, advising that as a rule of thumb, each resident should be provided with access to at least 0.5-1 hectares of green space within 300 meters of their homes, which is approximately a 5-minute walk. Evidence shows that the proportion of urban GSs improves mental health, including stress and sadness (Lee & Lee, 2019); however, according to the ISGlobal ranking, more than 60% of urban residents live in areas with limited access to GSs.

The increasing use of geographic information systems, advances in the measurement of environmental exposures and the development of specialized analytical methods to assess the impact of environmental factors on health (such as multilevel analysis, spatial autocorrelation analysis and weighted geographic models) have led to a significant increase in research publications in recent years (Diez Roux, 2001). The physical environment includes both natural and man-made aspects, as well as intangible elements such as traffic or safety

from crime (Swinburn et al., 1999), which can act as barriers or facilitators in determining PA.

The amount and manner in which people engage in PA, including type, frequency, intensity and duration, has been linked to various characteristics of the physical environment, such as the level of urbanization of the area in which they live, the design of the urban landscape (e.g. mix of land uses, street connectivity, availability of street lighting), transport infrastructure, availability of PA equipment, and natural features of the environment such as GSs, waterways and weather conditions (Saelens et al., 2003; Owen et al., 2004; Ding et al., 2011).

As a result, those working in public health have advocated the use of urban planning strategies and the implementation of local initiatives to create environments that are conducive to PA. This is based on the recognition that the physical environment can be an important factor in increasing PA at a population level, with evidence pointing to street characteristics, walkability and the mix of different urban areas as some potential drivers of PA (Carlin et al., 2017). The built environment is getting more and more attention in the promotion of PA, recognising GSs and the broad potential of environmental interventions to encourage substantial changes in population PA (Sallis et al., 2012).

Active transport also contributes to healthy levels of PA (Saunders et al., 2013). In addition, replacing motorized vehicle travel with active ways of transport has numerous secondary benefits, such as reduced traffic congestion, improved air quality, and fewer deaths due to traffic, air pollution, and inactivity (Rojas-Rueda et al., 2016; Xia et al., 2013).

A growing body of evidence shows that there is a strong correlation between the built environment of a neighborhood and PA-related behaviors (Giles-Corti et al., 2009; Sallis et al., 2016; Smith et al., 2017). This accumulation is specifically correlated with more walkable environments, i.e. they facilitate walking trips through better accessibility to destinations, street connectivity, the existence and quality of active transport infrastructure, etc. (McCormack & Shiell, 2011; Hunter et al., 2015; McGrath et al., 2015; Smith et al., 2017).

2.3. Virtual Nature

Technology has accompanied people since the beginning of humanity and has evolved with society. It has been a social companion that has allowed us to flourish as a species and is

as natural to us as nature itself. Therefore, this complementary part of the research is dedicated to a type of technology applied to the natural environment: Virtual Nature (VN).

It has long been known that CN provides people with a wide range of benefits in terms of physical health, mental health and cognitive function, to name a few (Bratman et al., 2012; Mason et al., 2022; Twohig-Bennett & Jones, 2018). However, access to nature can be difficult in some cases, such as for hospitalized patients (Nejati-Rodiek, & Shepley, 2016).

It has been proven that indirect experiences with nature, such as watching films or looking at photographs of nature itself, can temporarily improve health and cognitive function (Bratman et al., 2012; Mcsweeney et al., 2014; Pasca et al., 2021). As a result, in recent years more and more empirical data on the effects of exposure to VN have been found. It was possible for people to develop new environments for a variety of purposes thanks to technology and new advances in science, and this has also happened in the natural world thanks to current technologies such as virtual reality (VR), which seems to have attracted even more interest, especially since the outbreak of the Covid-19 pandemic (Ball-Huang & Francis, 2021). According to some studies, exposure to VR reduces negative affect and increases the positive one, which is also useful in reducing stress; in addition, psychophysiological tests have proven that the use of VR has helped achieve remarkable relaxation and mental resilience (Gentile et al., 2023; Spano et al., 2022).

In this sense, exposure to VN has also become a successful strategy in promoting pro-environmental attitudes and behaviors, and evidence suggests that social engagement with an attractive VN can influence these pro-environmental attitudes and behaviors (Chirico et al., 2023). Furthermore, people who are not very nature-friendly may feel more connected to it after viewing it in an immersive VR environment (Leung et al., 2022).

Even though it is a fairly recent technology, research has already been conducted on the potential benefits of VN and its differences compared to real nature (Browning et al., 2020). Some of these benefits are positive effects on relaxation, rest, cognitive functions, and pain experiences are among them (Léger & Mekari, 2022; Li et al., 2021), but little have these effects been studied among different virtual natural environments (Liscio & Masuch, 2019; Szczepańska & Cieślik, 2021). Similarly to the different levels of exposure in nature, we also have the same levels in VN: first, we would find nature observation, second would be direct exposure, and the third level would be intervention with nature in activities such as gardening or camping (Han & Wang, 2018).

According to Johnsen (2011), natural environments can potentially have direct and indirect effects on emotional processes, directly activating or reducing emotions and

indirectly influencing other important processes related to emotions or emotional regulation. Focusing on the virtual environment, Li et al. (2021) suggest that the main function of VN is relaxation, and that VN can contribute to recovery from attentional fatigue in the same way as the real natural environment. The authors also state that VR induces a sense of presence, which is associated with physiological arousal.

Mayer and others (2009) suggest that humans can find meaning and purpose in life by feeling truly connected with nature. A person's need to belong, i.e. to feel connected to a group, is one of the basic human needs, according to social psychologists. Similarly, the sense of belonging extends beyond the boundaries of our environment to include belonging to the natural world.

The need to belong is satisfied when people are in nature, and at such times people can experience numerous psychological benefits (Mayer et al., 2009; Mason et al., 2022). Additionally, as time passes, more is also known about the positive effects of nature on human physical and mental health. One of the ways in which natural environments affect mental health and well-being can be reduced to the notion of psychological renewal or restoration (Choe et al., 2020).

Despite promoting human-nature interaction, there are still significant numbers of people who have difficulty accessing ideal natural environments due to limited housing and physical conditions. These difficulties particularly affect the elderly and patients with disabilities or chronic illnesses. Therefore, there is a growing interest in virtual environments that represent nature to improve overall health status (Li et al., 2021).

Relaxation would be a key function of VN, referring to both psychological and physiological relaxation. The effects of relaxation tend to be more commonly identified by various physiological indicators such as heart rate variability, electrodermal activity, salivary cortisol levels, etc. In addition to doubling the sense of immersion, which is difficult to achieve with two-dimensional visual representations, VR can stimulate highly realistic virtual environments and may provide health benefits through VN (Li et al., 2021). However, as there is a small number of studies that compare two-dimensional media and VR, more research is needed to reach a general conclusion (Li et al., 2021). In most of the studies conducted in this area, subjects undergo a series of tests to determine the effect of VR on specific constructs before and after VR exposure. What is most commonly examined are the effects of VR on various emotional states and cognitive abilities (Bratman et al., 2012; Kim et al., 2011; Mason et al., 2022).

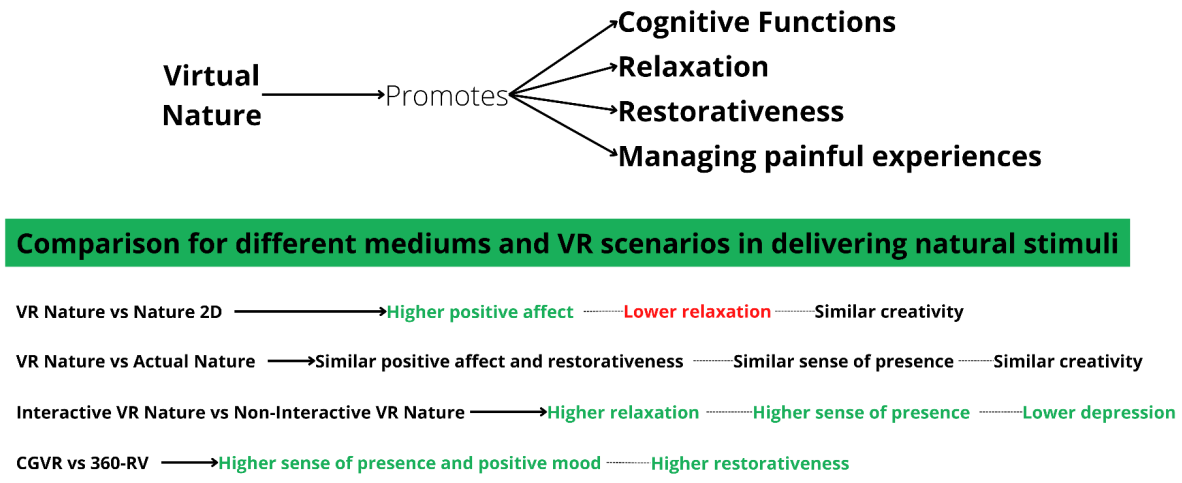
Similarly, many studies have examined the effect of VR on human cognitive abilities. To investigate the effect of VR on subjects' cognitive function, Kim et al (2011) targeted patients with acute stroke and cognitive impairment. The results of the research showed that VR aroused the subjects' motivation and interest, which directly affected aspects of attention. The study by Bratman et al. (2012) proved that CN, whether virtual or real, affects the cognitive functioning of humans, referring to the theories mentioned above (SRT and ART) that tried to explain how nature can positively influence the focus of attention. What is more, Mason et al (2022) even demonstrated that short-term exposure to natural conditions can have a positive effect on certain cognitive abilities.

In addition, it is also important to highlight the fact that VN stimulation in VR has individual differences and gender-specific effects due to different spatial orientation strategies between the sexes, where men and women maintain different emotional responses to the same natural environment (Davidov et al., 2023). When it comes to VN and VR in university students, we have little information about it, as evidence is limited and does not currently suggest that it provides specific benefits beyond those mentioned in this section in the area of health and well-being (Browning et al., 2023; Lau et al., 2023; Sneed et al., 2021).

Finally, as a visual summary, an overview of the general effects of VN and comparisons between the different exposed media is shown (Figure 14).

Figure 14.

Effects of virtual nature and comparisons between different environments and scenarios



Note. Adapted by the Author from the frame of Li et al., 2021. VRMV (Virtual Reality Motor Videogame).

Chapter 3: RESEARCH APPROACH

3.1. Objectives

The main objective of this study is to analyze the relationship between nature, PA and health, focusing in this case on university students as the target population. The sustainable component of the characteristics of GSs in the area of residence is also added so as to analyze their influence on this structure.

On the basis of the observational study carried out, the influence of these variables has been analyzed and other factors that may influence this system have been defined. The aim of this research is to analyze the importance of contact with the natural environment and the effect and beneficial reciprocity of a good relationship with nature, in this case focused on the university population.

Taking into account the theoretical framework and the questions that have arisen from reading and understanding it, this section lists the objectives of this study, which in turn serve to guide its progress and mark its design. In the second part it has been found the research hypotheses, whose purpose is to serve as a preliminary objection to the proposed study. Both objectives and hypotheses have been divided into primary and secondary, or general and specific, according to the proposed hierarchy. Thus, the primary aim of the project is to analyze whether CN influences PA levels and health status in university students.

Finally, it is necessary to mention that in this study it has been found an additional section in which a comparison is made between two different populations, a national and a foreign one. This section largely shares the objectives, hypotheses and methodology of the main study.

On the other hand, the theoretical section is followed by an experimental study, with a pre-post test, which studies the differences between the effects on cognitive performance and state of well-being between a non-interactive virtual nature and an interactive one. The population chosen for this research was undergraduate and master students of Psychology at the University of Zadar in Croatia. The target population was selected based on their availability through collaboration with the university, rather than the type of study. Based on these two premises, the specific objectives are as follows.

3.1.1. Objectives of the Observational Studies

- Objective 1: Analyze whether CN (ECN) favors health status (SF-12) in university students.
- Objective 2: Analyze whether CN (ECN) favors PA levels (IPAQ-SF) in university students.
- Objective 3: Analyze the relationship between PA levels (IPAQ-SF) and health status (SF-12) in university students.
- Objective 4: Analyze the relationship between PA levels (IPAQ-SF), health status (SF-12), CN (ECN) and GSs characteristics with the amount of PA performed in nature (item 5 - ECN) in university students.
- Objective 5: Observe the differences between the secondary variables (AdHoc questionnaire) in the data obtained from the primary objectives.
- Objective 6: Analyze the relationship between the quantity/distance/quality of GSs in the area of residence (AdHoc questionnaire) and the CN (ECN) in university students.
- Objective 7: Analyze the relationship between the quantity/distance/quality of GSs in the area of residence (AdHoc questionnaire) and health status (SF-12) in university students.
- Objective 8: Analyze the relationship between the quantity/distance/quality of GSs in the area of residence (AdHoc questionnaire) and PA levels in university students (IPAQ-SF).
- Objective 9: Carry out a demographic distribution of the study variables in the Spanish territory.
- Objective 10: Compare the results of the study variables between two university populations, Spanish and Croatian (Study II - International Comparison).

3.1.2. Objectives of the Experimental Study

- Objective 1: Analyze the effects of interactive and non-interactive virtual nature on the stress level of university students.
- Objective 2: Analyze the effects of interactive and non-interactive virtual nature on the state of mind of university students.
- Objective 3: Analyze the effects of interactive and non-interactive virtual nature on the cognitive performance of university students.

- Objective 4: Study the influence of nature connection on the relationship of interactive and non-interactive virtual nature on the stress level of university students.
- Objective 5: Study the influence of nature connection in the relationship of interactive and non-interactive virtual nature on the mood of university students.
- Objective 6: Study the influence of nature connection in the relationship of interactive and non-interactive virtual nature on the cognitive performance of college students.

3.2. Hypothesis

3.2.1. Hypothesis of the Observational Studies

Taking into account the objectives described in the previous section and also the theoretical basis presented, a general hypothesis is formulated to establish its acceptance or nonacceptance on the basis of the data obtained after the research. Therefore, at a general level, the following hypothesis has been elicited:

- Hypothesis 1: "A higher level of CN favors a better state of health and a higher level of PA in the university students surveyed. In turn, the characteristics of the GSs influence this relationship".

Similarly, this primary hypothesis is divided into three secondary hypotheses:

- Hypothesis 2: "The variables CN, health status and PA level are related to one another".
- Hypothesis 3: "The distance, quality and/or quantity of GSs from the area of residence have an impact on the CN, health and PA level of the university students surveyed"
- Hypothesis 4: "Gender and age, together with the other secondary variables, influence the CN, PA and health levels of the university students surveyed".

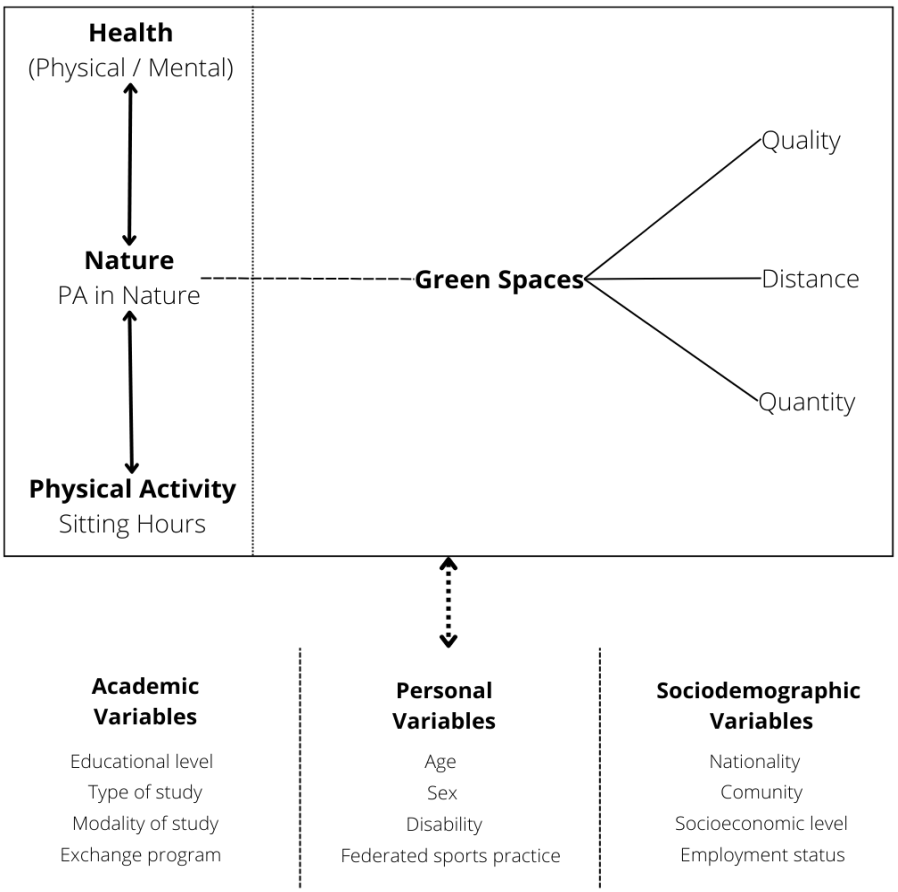
Likewise, the international comparison has as a specific hypothesis that elicits the observation of the differences and similarities of relationships between these variables in two disparate cultural and social contexts.

- Hypothesis 5: “Variations in cultural and social contexts will result in differential relationships between individuals' engagement with the natural environment, physical activity levels, and overall well-being among university students”.

Finally, the following figure is a visual representation of the relational model of the study variables and hypotheses (Figure 15).

Figure 15

Relational model of the suggested observational study



3.2.2. Hypothesis of the Experimental Study

The general hypothesis of the study is presented based on the previous aims. By allowing for more active participation and exploration, interactive virtual natural environments are expected to be more beneficial to cognitive and emotional well-being than non-interactive virtual natural environments, where only passive observation of the environment is possible. In this sense, the hypothesis would be: "Short-term exposure to interactive virtual natural environments will result in greater improvements in cognitive function, stress reduction, and perceived restoration in participants compared to non-interactive virtual natural environments".

Chapter 4: OBSERVATIONAL STUDY I - Spanish Population

4.1. Methodological Design

The following chapter describes the methodological aspects of the research development. This study is part of the UCV/2021-2022/118 project, whose ethics committee of the Catholic University of Valencia can be seen in Annex 3.1. First, it has been described the sample used, its main characteristics in relation to the proposed research and the selection criteria used. This is followed by a description of the instruments used in the study and their characteristics.

Next, the study describes the procedure that has been followed for administering the questionnaire used and for collecting information, as well as the sample size and the type of sampling. Finally, it also specifies the statistical procedure used to achieve the objectives.

4.1.1. Research Design

A quantitative methodology has been used for this study: the study is cross-sectional and correlational in nature between the variables through a series of questionnaires. A measurement of the aforementioned variables was also carried out on a specific sample of university students at a specific point in time. The research itself is descriptive in nature, as the data is drawn from the sample in question.

The precise purpose of this research design is to explore and establish relationships between the selected variables, using a quantitative approach to analyze the data collected through anonymous online questionnaires applied to university students. Data collection techniques include electronic distribution of the questionnaire to the selected sample. Voluntary participation has been encouraged and the anonymity of the participants has been guaranteed in order to obtain honest and unbiased responses.

The data collected have been subjected to statistical analysis using appropriate techniques such as correlation analysis to provide information on the strength and direction of the relationships between the identified variables. We anticipated the possibility that some participants may not respond truthfully or that biases may arise in the sample. To address these possible objections, confidentiality and anonymity were emphasized, encouraging honesty in the responses.

The research was conducted in virtual environments, taking advantage of online platforms for questionnaire distribution and data collection. The study was carried out during the 2022-2023 academic year, including the questionnaire design phase, questionnaire distribution, data collection, statistical analysis and interpretation of results.

4.1.2. Field of Study

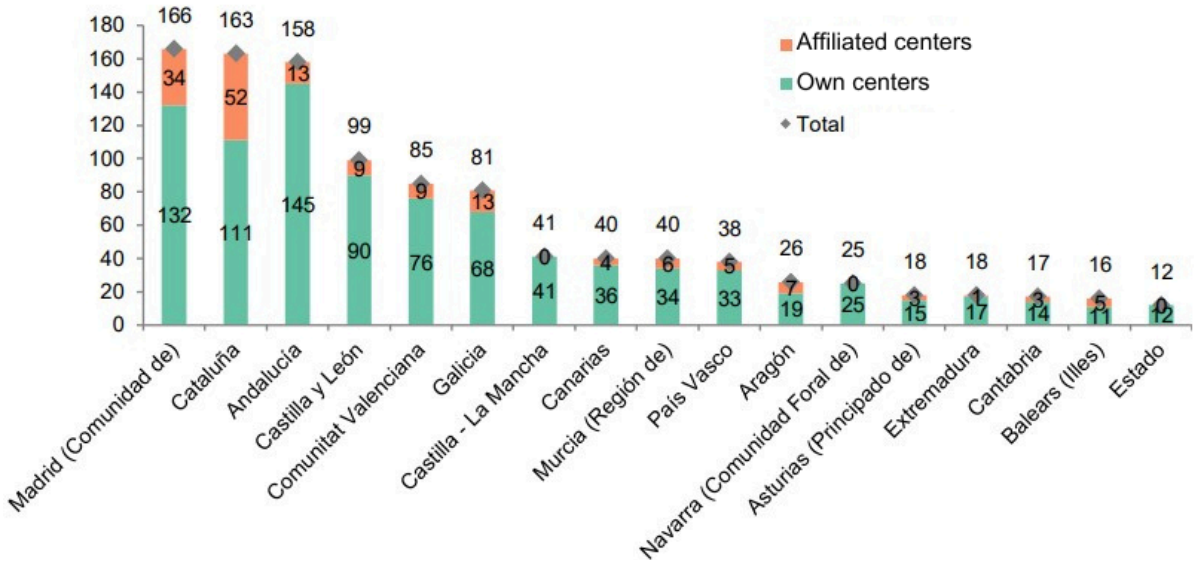
This research is conducted in the university setting: the target population of the study were university students from Spain. A national sample was chosen rather than a community sample in order to obtain a larger number of participants and therefore more information and more relevant results.

It was decided to use the university population because of the ease with which a questionnaire can be sent out quickly and massively thanks to new technologies, and also because it is a group that has been little studied in this area. At the same time, this geographical framework makes it possible to carry out a specific analysis of each designated area and, consequently, a comparison between them.

According to the report Facts and Figures of the Spanish University System (2022-2023), there are a total of 86 active universities, 50 of which are public and 36 are private, with more than 1,500,000 students enrolled, 15% of which are enrolled in non-face-to-face universities. Around a third of these young adults (18-24 years old) are currently studying at university. Nextly a graph can be seen (Figure 16), taken from the same document, visualizing the different Spanish institutions.

Figure 16

Distribution of the number of universities based on autonomous region and type of center



Note: 2022-2023 academic year

4.1.3. Selection criteria

The selection criteria for the research sample are described. Regarding the inclusion criteria, everyone who was enrolled as student in one of the listed universities in Spain was accepted in the study.

Referring to the exclusion criteria, those students whose current place of residence was outside the Spanish territory were excluded from the study. The reason behind this criterion was to collect data exclusively in Spain, since the questionnaire assesses characteristics specific to the place of residence and information was sought only from the territory of the research population.

4.1.4. Sample Calculation

In this project the target population was university students from institutions in Spain. Aiming for the sample to be representative of the reality of the country, the sample size calculation has been carried out for a finite population.

Below is the calculation of the sample size necessary to carry out a quantitative investigation in an extensive population of 1,500,000 individuals. The main objective is to obtain results with a high level of confidence (95%) and an acceptable margin of sampling error of 5%. The importance of this calculation lies in ensuring that the selected sample is representative of the total population, thus allowing accurate extrapolation of the results.

Parameter Definition:

- Study Population (N): A total population of 1.500.000 individuals is considered.
- Confidence Level: A level of confidence is sought from the 95%.
- Critical Value (Z): The critical value Z for a confidence interval of 95% is 1,96.
- Estimated Proportion of the Population (p): In the absence of precise information, we assume a proportion of 0,5.
- Sampling Error (E): A margin of error of 5% is established, equivalent to 0,05.

The sample size (n) is calculated using the simplified formula: $\mathbf{n = Z^2 * (p) * (1-p) / E^2}$. By substituting the values $\mathbf{1,96^2 * (0,5) * (1-0,5) / 0,05^2}$ and performing the calculations we obtain an "n" of 385. Therefore, a sample size of 385 individuals is suggested to achieve a confidence level of 95% with a margin of error of 5%. This methodological approach will strengthen the validity and reliability of the study results, ensuring that the selected sample is large enough to represent the diversity and variability present in the population of interest.

4.1.5. Participants

The participants in this research were university students with their current residence being in Spain, including any type of study, sex and age. The results section (4.2.2.1. Participants) describes the sample to more depth.

After the data collection, responses were received from 29 Spanish institutions, one third of the total, with a maximum of 711 responses, 9 of which were discarded because they were not Spanish residents, leaving a total of 702 participants. This is an adequate sample size if we consider the number of university students in Spain.

4.1.6. Measuring Instruments

The selection and description of the measurement instruments used in the research are explained. These instruments have been used as the basis for data collection, have been validated and are reliable tools for their purpose. Therefore, the instruments used to measure three of the main variables of the study are presented below: CN, PA level and health level.

4.1.6.2. *Escala del Contacto con la Naturaleza (ECN)*

Kamitsis & Francis (2013) define CN as direct physical and/or sensory contact with the natural environment. This contact was assessed using the Nature Exposure Scale-II (NES-II) (Wood et al., 2019), in its Spanish version called *Escala del Contacto con la Naturaleza* (ECN). This scale examines CN in everyday life and less everyday environments and provides a measure of CN in different domains of an individual's life, including moments of PA (Rogerson et al., 2020).

This scale contains the four items of the original scale, two of which are designed to assess CN in everyday life and two others to assess exposure outside everyday life, together with two extra items focusing on additional questions assessing CN during PA. Each question used is scored on a 5-point Likert scale (1 meaning "much/a lot", 5 meaning "little/not at all"), where the higher the score, the higher the CN.

This scale was used because it is the only instrument validated for this purpose, as it is a short, direct scale that covers the necessary information to know the level of exposure of an individual to the natural environment. The following table (Table 1) summarizes this scale and its different items.

Table 1. Outline of the ECN

Level of contact with natural environments	**Degree of contact**	**Degree of attention**
Everyday life	Item 1	Item 2
Outside of everyday life	Item 3	Item 4
During physical activity	Item 5	Item 6

4.1.6.3. International Physical Activity Questionnaire - Short Form (IPAQ-SF)

There are a variety of methods and devices that can be used to quantify an individual's PA levels. It has been observed that there is evidence that the use of questionnaires is an equally effective, practical and accurate tool as the gold-standard criterion used to measure physical fitness, such as accelerometry (Lee et al., 2011).

Therefore, PA was analyzed using the International Physical Activity Questionnaire (IPAQ) in its short version in Spanish (Rodríguez-Muñoz et al., 2017), which determines the

amount of PA, light (lpa), moderate (mpa) and vigorous (vpa), with the corresponding frequency and duration, performed by a person on a daily and weekly basis. Table 2 shows the breakdown of the items.

In the same questionnaire, there are several ways to calculate the amount of PA performed. It has been chosen to use the following version of the calculation of Mets (Metabolic Index Units) as it is the most universal and generally accepted. The formula used to calculate Mets is: (3.3 x minutes of lpa x days per week) + (4 x minutes of mpa x days per week) + (8 x minutes of vpa x days per week) = Total Mets (Total Physical Activity performed).

WHO recommends that the adult population aged 18-64 years should engage in at least 150-300 minutes of moderate aerobic physical activity or at least 75-150 minutes of vigorous aerobic physical activity, or an equivalent combination of moderate and vigorous activities throughout the week. It also recommends that moderate aerobic PA should be extended beyond 300 minutes or vigorous aerobic PA should be extended beyond 150 minutes (or an equivalent combination of moderate and vigorous activities throughout the week) for additional health benefits.

Next, a table (Table 2) is presented as an outline of the IPAQ-SF questionnaire. This instrument splits the subjects into 3 groups: insufficient PA (no PA at all or the PA performed is insufficient to reach the other categories), minimal PA (3 or more days of vpa for at least 25 minutes a day, or 5 or more days of mpa and/or walking for more than 30 minutes a day, or 5 or more days of a combination of walking and/or vpa/mpa that achieves an energy expenditure of at least 600 Mets) and high PA (performing vpa at least 3 days a week that achieves an expenditure of 1500 Mets, or performing 7 or more days of a combination of walking and/or vpa/mpa that achieves an energy expenditure of at least 3000 Mets).

Table 2. Outline of the IPAQ-SF

Type of activity	**Number of days of the week**	**Total time per week**
vpa	Item 1	Item 2
mpa	Item 3	Item 4
walking	Item 5	Item 6
Total sitting time on a working day: Item 7		

4.1.6.4. 12-Item Short Form Health Survey (SF-12)

The assessment of health status used in this research proposal was carried out using one of the most widely used questionnaires in both clinical and research settings, the SF-36 (Vilagut et al., 2005). This questionnaire covers aspects such as physical function, physical role, bodily pain, general health, vitality, social function, emotional role, mental health and health transition.

In this study it has been preferred to assess health using the second version of the SF-12 questionnaire (Vera-Villarroel et al., 2014), which is one of the short forms of the SF-36 and therefore more practical to administer. This questionnaire aims to assess both positive and negative health states at a general level by dividing them into two main dimensions: physical and mental. The SF-12 assesses 4 aspects in each of these dimensions in a similar way to its extended version: physical function, physical role, bodily pain and general health for the physical dimension and vitality, social function, emotional role and mental health for the mental dimension.

The questionnaire uses a score ranging from 0 to 100 with Likert-type response options of 3 or 5 points, where a higher score indicates a better quality of life in relation to the person's health. A table (Table 3) of the different elements of the SF-12 and the items that assess them is given below.

Table 3. Elements of the SF-12 and evaluative items

Physical Dimension	
Physical function	Items 2 and 3
Physical role	Items 4 and 5
Bodily pain	Item 8
General health	Item 1
Mental Dimension	
Vitality	Item 10
Social function	Item 12
Emotional role	Items 6 and 7
Mental health	Items 9 and 11

4.1.7. Questionnaire Design

The final questionnaire that was sent to the study target population is structured in six sections. It contains an introductory part with the legal basis, followed by a series of questionnaires to analyze the variables of the study based on the sample characteristics and measurement instruments. Each section and its tasks are then specified, as shown in Table 4.

- Section 1: Title, introduction, objective and main data of the survey
- Section 2: Participant Information Sheet (PIS) and Informed Consent (IC)
- Section 3: Ad hoc questionnaire
- Section 4: *Escala de Contacto con la Naturaleza* (ECN)
- Section 5: Health questionnaire (SF-12)
- Section 6: Lifestyle Questionnaire (IPAQ-SF)

Table 4. Questionnaire outline level

Section		Items
1	Introduction and Explanation	-
2	PIS / IC	-
3	Ad hoc questionnaire	17
4	ECN	6
5	SF-12	12
6	IPAQ-SF	7
	Total questionnaire questions:	**42**

4.1.7.1 Online Questionnaire

The questionnaire was administered using Google Forms. It is a simple tool to implement and easy to distribute as it can be sent in a link or in a QR code format, and the software itself delivers the results in xls format. The full questionnaire can be found in Appendix 1.

4.1.7.2. Main Variables

The main research variables are listed below:

- *Contact with nature:* analyzed using the ECN
- *Level of Physical Activity:* analyzed using the IPAQ-SF
- *Level of Health:* analyzed using the SF-12.
- *Green spaces:* the characteristics of the GSs in the participant's area of residence are analyzed using three questions.
    - *Distance:* GSs are considered health-supporting elements since they offer a variety of free activities close to the population together with their environmental role and their associated benefits; broadly speaking, it has been observed that the shorter the distance between GSs and the area of residence, the greater the likelihood that the person performs PA and a positive correlation with their health levels (Toftager et al., 2011; Cox et al., 2017). It is assessed with a specific question in the personal data questionnaire using a scale from 1 to 4.
    - *Quality:* the existence of GSs is not the only thing that determines their benefits, as no matter how close they are, if they are not accessible, they will not be used. Therefore, the type, access, functions, infrastructure, degree of cleanliness, among other qualities, will be crucial in determining the quality of the GSs and their attractiveness for the population of the area. Evidence tells us that the quality of GSs in an area correlates with people's health status and psychosocial well-being (Nguyen et al., 2021; Yessoufou et al., 2020). It is assessed with a specific question in the personal data questionnaire through a scale of 1 to 5.
    - *Quantity:* the amount of green space in a location is related to people's quality of life (Ruijsbroek et al., 2017; Geneshka et al., 2021), although current evidence suggests that it is not so much the quantity per se that influences the most, but the use that is made of it (Yessoufou et al., 2020); therefore, GSs play a social and awareness-raising role as sources for social inclusion and equity (Rigolon et al., 2021). It is subjectively assessed on the same 1-5 scale used to measure quality.

4.1.7.3. Secondary Variables

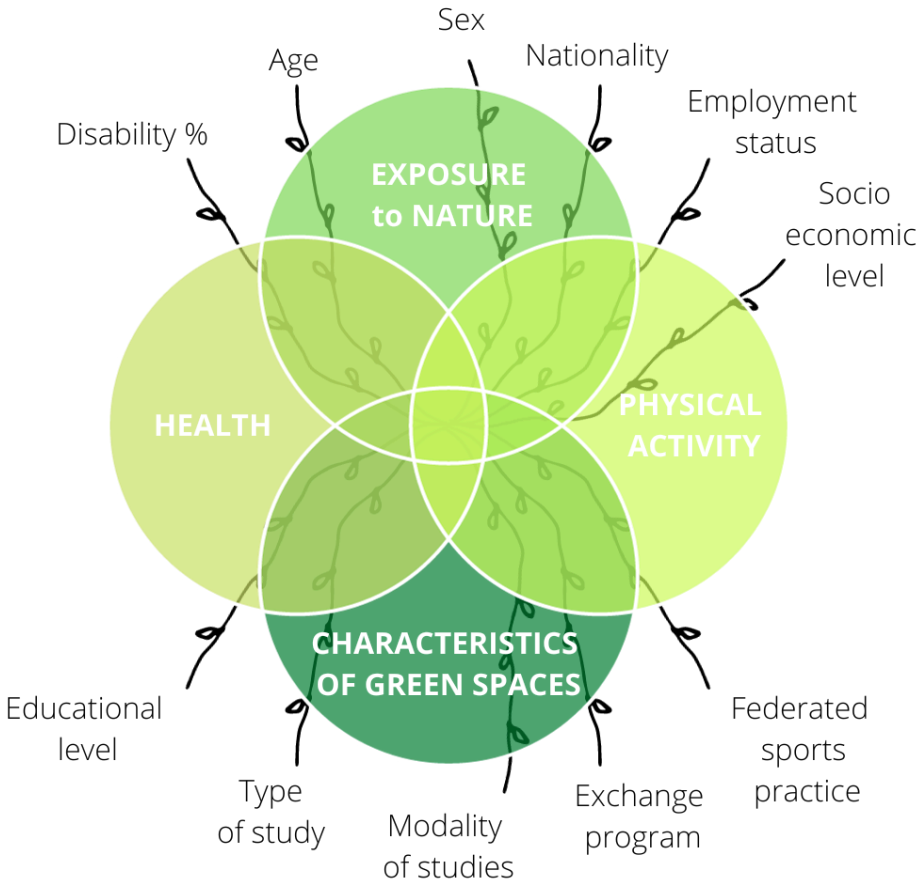
The secondary variables to be addressed in the research are listed below:

- *Personal Variables:*
    - Age
    - Sex
    - Disability and disability % (No disability / Level 1. Disability 0% / Level 2. Disability 1 to 24% / Level 3. Disability of 25 to 49% / Level 4. Disability of 50 to 70% / Level 5. Disability equal to or higher than 75%)
    - Federated sports practice (Yes / No)
- *Sociodemographic variables:*
    - Nationality
    - Current Spanish residence (Yes / No)
    - Place of residence
    - Socio-economic level (Low / Medium / High)
    - Active employment status (Yes / No)
- *Academic Variables:*
    - Institution
    - Level of studies (Bachelor’s degree / Master's / Doctorate / Other)
    - Current type of study
    - Modality of study (Online / face-to-face)
    - ERASMUS, exchange program or similar (Yes / No)

The set of variables of the study in question is presented graphically below (Figure 17).

Figure 17

Visual outline of the observational study variables



Note. Variables such as Spanish residence, institution and place of residence have been omitted as they are demographic and not universal values.

4.1.8. Procedure

This quantitative study focused on the analysis of specific aspects related to the Spanish university student population. When it comes to its structure, the research was clearly divided into two parts: first, the collection of the data was performed in two consecutive phases, designing of the questionnaire with the aforementioned variables and implementation of the same; secondly, the results of the questionnaire underwent subsequent analysis.

During the data collection phase, the principal investigator contacted multiple universities to present the study. For maximum outreach, the questionnaire and the necessary information related to it were also shared through several student social media accounts.

The participating students were sent an online link to access the questionnaires, which included both the Participant Information Sheet and the Informed Consent. By signing both of these documents, the students gave their consent for the processing of their personal data for scientific research. Access to questionnaire participation was available during the second half of the 2022-2023 academic year until the beginning of the next academic year.

In order to maintain participant confidentiality, during the data analysis phase the centrally collected data were analyzed in aggregate by the principal investigator, so the analysis was not carried out individually. At the same time, the data analysis phase was completed at the beginning of the 2023-2024 academic year, which ensured a thorough and rigorous analysis of the information collected.

A data protection plan, which complies with current data protection legislation, was followed throughout the analysis process. This plan ensured the confidentiality and security of the information collected at all stages of the study and was detailed in the ethical section.

The study presented its findings on the basis of the identification of patterns and trends at an aggregate level. The interpretation of the results were carried out carefully and provided valuable information for the understanding of the issues under consideration.

4.1.9. Statistical Analysis

For the statistical analysis of the study objectives, a descriptive analysis of the sample was carried out first. Means, frequency, variance and indexes of distribution shape of the study variables were calculated.

Welch's t-tests and t-tests were then performed to examine the differences of the study variables and Pearson's coefficients were calculated to study the correlations between the variables. Corresponding models were also run and estimated using multigroup path analysis to examine the proposed mediating role of CN in the relationship between GSs, PA and health characteristics.

Finally, using Chi-square difference tests, differences between the relationships of the analyzed models of the different variables were also examined, comparing the final model and models with equality restrictions on the coefficients of the individual paths to optimize the analysis and relevant conclusions. The significance level chosen was $p \leq 0.05$. The Statistica™ 14 package was used for data analysis and Mplus 8.7 was used to perform the path analysis.

4.2. Results

4.2.1. Validation and Translation to Spanish of the Nature Exposure Scale II (NES-II)

The translation and validation into Spanish of the NES-II have been carried out in order to be used in the main study. This has been done because there was no specific validated instrument in Spanish for this purpose[1] (Martínez et al., 2023).

Nature has a great impact on our lives, not only at the health level (Baceviciene & Jankauskiene, 2022; Frumkin et al., 2017), but also at the social and cultural levels (Kazdin & Vidal-González, 2021). Therefore, having tools to assess exposure to this medium is essential to understand the relationship that people and society itself have with it, and the effects that arise or may arise from this relationship. In turn, these effects provide us with relevant information to reinforce the evidence base of the relationship between natural environments and key areas such as health (Park et al., 2011).

There are few questionnaires and/or scales that assess the relationship people have with the natural environment, and none of them is available in Spanish. Currently, there are several main tools for this purpose, some of them are the Connectedness to Nature Scale (CNS) (Mayer & Frantz, 2004) and the Nature Exposure Scale (NES) (Wood & Smyth, 2019). Therefore, in order to be able to use the NES-II (the second version of the latter scale) in this project, a study was carried out with the aim of translating and validating the original English questionnaire into Spanish, so as to be able to use it as a quality instrument in future research in this language and field of study.

This research was carried out in collaboration with the Catholic University of Valencia (UCV in Spanish), where the NES-II was translated using a structured procedure to produce the ECN. This study is complementary to the UCV/2021-2022/118 project, whose ethics committee of the Catholic University of Valencia can be seen in Annex 3.2.

Once translated, a cross-sectional observational study was carried out to confirm its validity and consistency using Cronbach's alpha and factor analysis of the different items.The translation of the scale followed an organized methodology to ensure its reliability. A similar method to the one used by Pilar et al. (2018) was used to translate and validate the NES-II.

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[1]This full study is available at:https://doi.org/10.25267/Rev_educ_ambient_sostenibilidad.2023.v5.i2.2102

The steps to be followed for the development of the study are as follows: (1) translation of the original scale into Spanish by the Principal Investigator (PI) with the collaboration of a group of experts in the field of the scale and the research, (2) review of this new scale by the PI, (3) a new translation of this second version into the main language by a native translator, (4) comparison and review of the version obtained with the original scale by the PI, (5) agreement of the translation to ensure conceptual equivalence by the PI and double-checking doubts with the translator, (6) pilot test: the translated scale was given to 10 university students for evaluation, together with a short accompanying text to collect doubts or questions that might arise regarding comprehension and wording, and the overall evaluation obtained was examined; (7) the results of the pilot test were analyzed and the translation of the scale was finalized by the PI, and (8) the scale was edited and a final report was formalized.

Based on this process, an observational study was carried out in which the translated scale was given for evaluation to a group of university students; this sample was obtained mainly from the Faculty of Physical Activity and Sport Sciences of the UCV, together with other students of the same university from other faculties. Participants were selected randomly and consecutively until the sample was complete.

In order to have an adequate sample for the validation of the instrument, the sample size was calculated with a minimum of 200 participants, based on the study by Roco et al. (2021), due to the number of items and the scope of the questionnaire used. All subjects were informed of the purpose of the study and asked for their written consent. The scale was delivered virtually and completed on the same day of delivery.

For the statistical analysis, the program Statistica™ 14 was used, where the reliability of the translated scale was estimated with Cronbach's alpha (Pilar et al., 2018, Roco et al., 2021) and an exploratory factor analysis was performed on the different items (Wood & Smyth, 2019; Batista-Foguet, 2014). In the descriptive section, means and standard deviations were used when the variables had a normal distribution (Pilar et al., 2018): a significance level of $p < 0.05$ was used. Find below a table (Table 5) showing the distribution of responses, their frequencies and percentages.

Table 5. Distribution of the answers

Item / Answer	1	2	3	4	5
1	12 (6%)	58 (29%)	79 (40%)	38 (19%)	13 (7%)
2	7 (4%)	21 (11%)	60 (30%)	62 (31%)	50 (25%)
3	8 (4%)	24 (12%)	59 (30%)	49 (25%)	60 (30%)
4	3 (2%)	17 (9%)	51 (26%)	62 (31%)	67 (34%)
5	27 (14%)	36 (18%)	62 (31%)	47 (24%)	28 (14%)
6	13 (7%)	26 (13%)	67 (34%)	62 (14%)	38 (19%)

Note. Frequency and percentages: n (%)

Table 6 shows the results of the descriptive analysis per item, the mean, the correlations and Cronbach's α. The estimation of the reliability of the scale by means of Cronbach's α for each dimension was quite homogeneous, giving an overall result of 0.83. Both the mean of the correlations of each item with the other items and the item-total correlations were > 0.4.

Table 6. Descriptive analysis per item

Item	Average	Standard deviation	Inter-item correlation	Total-item correlation	Cronbach's α if element was removed
1	2.910	0.988	0.370	0.49	0.82
2	3.635	1.076	0.486	0.66	0.79
3	3.645	1.147	0.461	0.63	0.79
4	3.865	1.026	0.414	0.55	0.81
5	3.065	1.232	0.466	0.63	0.79
6	3.43	1.132	0.464	0.63	0.79

In Table 7 it can be seen the different factor loadings for each item of the translated scale, with standardized results for items 2 to 6, which result in values lower than 1. Item number 1 is an exception, as it has a higher factor loading (3.23), accounting for 53.9% of the total variance, which has been eliminated from the table as it has a correlation value below the proposed cut-off value of 0.40, indicating that it is not suitable for factor analysis.

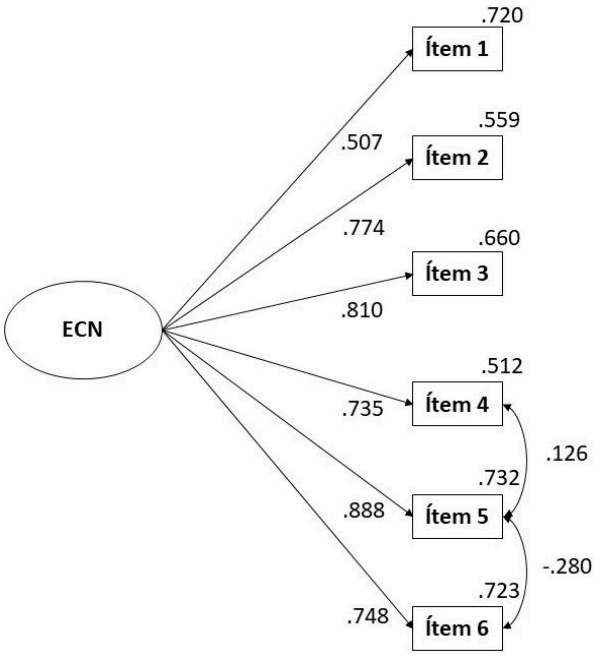
Table 7. Factor Loadings for the different items of the modified scale

Item	Factor Loading
2	0.82
3	0.88
4	0.69
5	0.98
6	0.87

Finally, Figure 18 shows the model selected after the confirmatory factor analysis. This model shows the correlation residuals between items 4-5-6, revealing better adjustment rates among all the models analyzed and indicating an acceptable model (ML $\chi 2$ = 35.705 / MI $\chi 2$ = / 430.029 / MI df = 15.000/ RMSR = 0.057 / RMSEA = 0.088 (90% CI) / GFI = 0.950 / AGFI = 0.850 / CFI = 0.930 / AIC = 0.320 / degrees of freedom = 7).

Figure 18

Confirmatory analysis model of the ECN



In conclusion, it should be mentioned that this scale was chosen for validation and translation because it is the only one in use and the only one available on the subject in question; likewise, no other validated instruments measuring CN have been published in Spanish, being this one the first of its kind.

As for the results, the reliability tests are in the same range as the original studies (0.81) (Wood & Smyth, 2019) and show a satisfactory internal consistency higher than 0.7, therefore being within acceptable values; the same happens with the results of the factor analysis. In short, thanks to the results obtained, the *Escala del Contacto con la Naturaleza* (ECN) is a valid and reliable tool for measuring contact with the natural environment.

4.2.2. Results of the questionnaire

The data from the different sub-questionnaires that made up the main questionnaire are presented, concretely the ECN, the SF-12, the IPAQ-SF and the characteristics of the GSs.

4.2.2.1. Participants

The average age of the participants in this sample was 21 years, with a standard deviation of 3 years. More than 400 of the respondents were male, i.e. around 60%, and only 3% reported any kind of disability, while a third of the students reported belonging to some kind of sports federation.

Regarding the academic variables, it can be seen that the majority of the participants, almost 90%, were undergraduate students, compared to 8.5%, who were pursuing a Master's degree, and only 1.6% were pursuing a PhD. In terms of the type of studies pursued, half of the sample belonged to the field of Health Sciences, followed by a quarter of students in Social and Legal Sciences, followed by Engineering and Architecture, Natural Sciences and Arts and Humanities, in that precise order. Practically all students, 96.3%, were studying in a face-to-face environment and only 2.8% were on an exchange programme.

The socio-demographic variables show that less than 4% of the respondents were foreigners. It should be noted that the community with the highest participation was Valencia, with almost a third of the replies, followed by the Community of Madrid (11.7%) and Catalonia (9.3%). At a socio-economic level, 60% of the sample indicated that they were in the middle level, while the remainder were evenly distributed between the low and high levels. It must also be highlighted that almost half of the students surveyed, 40.6%, were in active employment while studying at university. Finally, Table 8 and Figure 19 provide a summary of the descriptive data presented.

Figure 19

Main graphs about the sample of participants

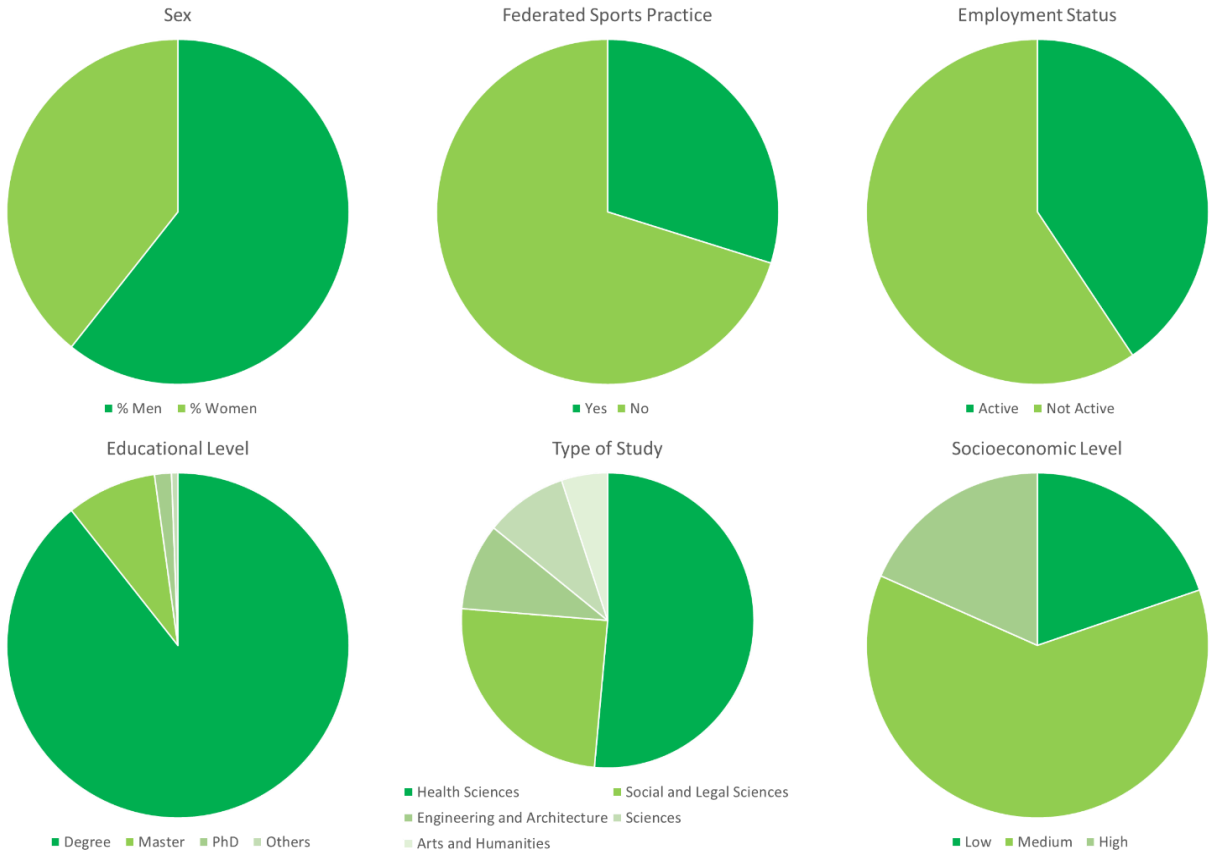


Table 8. General descriptive parameters of the study

Variables	N (%)
Sex	
Male	426 (60,7%)
Female	276 (39,3%)
Disability	
No disability	679 (96,7%)
Level 1	8 (1,1%)
Level 2	10 (1,4%)
Level 3	3 (0,4%)
Level 4	1 (0,1%)
Level 5	1 (0,1%)
Federated sport	209 (29,8%)
Institutions	29 (33,7%)
Level of education	
Bachelor's degree	627 (89,3%)
Master's degree	60 (8,5%)
PhD	11 (1,6%)
Others	4 (0,6%)
Fields of study	

Health Sciences	361 (51,4%)
Social and Legal Sciences	174 (24,8%)
Engineering and Architecture	67 (9,5%)
Sciences	64 (9,1%)
Arts and Humanities	36 (5,1%)
Modality of study	
Face-to-face	676 (96,3%)
Online	26 (3,7%)
Exchange program	20 (2,8%)
Nationalities	
Spanish	676 (96,3%)
French	7 (1,0%)
Romanian	4 (0,6%)
Moroccan	4 (0,6%)
Portuguese	3 (0,4%)
Colombian	2 (0,3%)
Cuban	2 (0,3%)
Chilean	1 (0,1%)
English	1 (0,1%)
Andorran	1 (0,1%)
Bolivian	1 (0,1%)
Communities	
Valencian Community	200 (28,5%)
Community of Madrid	82 (11,7%)
Catalonia	65 (9,3%)
Andalusia	47 (6,7%)
Aragon	36 (5,1%)
Principality of Asturias	36 (5,1%)
Castile and León	35 (5%)
Community of Navarre	35 (5%)
Galicia	31 (4,4%)
Canary Islands	26 (3,7%)
Extremadura	26 (3,7%)
Region of Murcia	24 (3,4%)
Cantabria	17 (2,4%)
Balearic Islands	15 (2,1%)
La Rioja	12 (1,7%)
Basque Country	8 (1,1%)
Castilla La Mancha	7 (1%)
Socioeconomic status	
Low	139 (19,8%)
Medium	434 (61,8%)
High	129 (18,4%)
Active employment status	285 (40,6%)

4.2.2.2. Main Variables

Regarding the results of the questionnaires, participants reported an average score of 3.4 out of 5 in the ECN, which was the same score found for one of its items indicating the amount of PA in the natural environment. As for the characteristics of the reported GSs, both

quality and quantity were rated 3.2 out of 5, and almost 40% of the students reported that the closest natural area to their home was between 300 meters and one kilometer away.

On the other hand, the health of the participants was good on average, with 75% scoring better in the physical area (85%) than in the mental area (69%). Finally, almost two-thirds of the sample reported minimum levels of PA, compared to 25% who reported high levels, and only just under 10% reported insufficient PA. The average number of sitting hours was almost 5.5 hours. Table 9 and Figure 20 provide more details of these data.

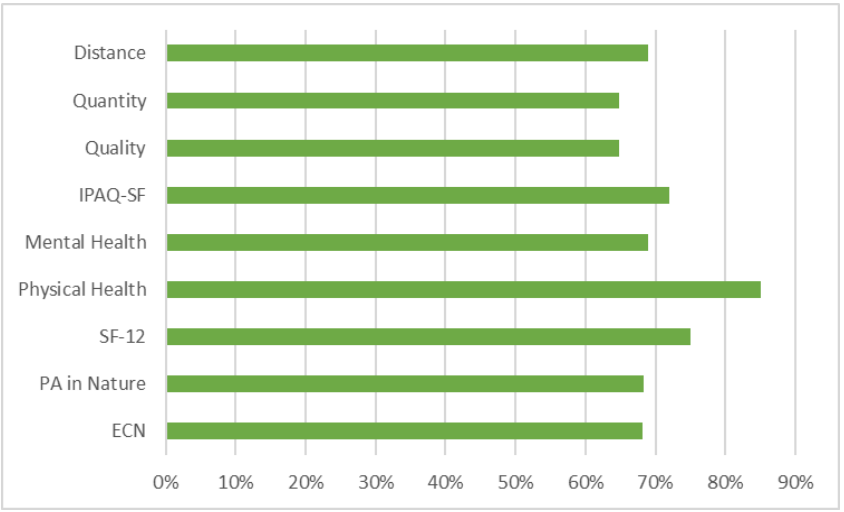
Table 9. Overall result of the main study variables

	N (%)	Average	SD	S	K
ECN (1-5)	-	3,41	0,83	-0,26	-0,49
PA in nature	-	3,42	1,16	-0,32	-0,71
SF-12 (%)	-	0,75	0,14	-0,75	0,43
Physical Health	-	0,85	0,15	-1,52	2,67
Mental Health	-	0,69	0,15	-0,48	-0,12
IPAQ-SF (1-3)		2,16	0,57	0,00	-0,14
Insufficient Activity	68 (9,7%)	-	-	-	-
Minimum Activity	457 (65,1%)	-	-	-	-
High Activity	177 (25,2%)	-	-	-	-
Sitting hours	-	5,42	1,61	0,07	2,82
Green Spaces					
Quality (1-5)	-	3,24	1,04	-0,14	-0,58
1	33 (4,7%)	-	-	-	-
2	137 (19,5%)	-	-	-	-
3	239 (34%)	-	-	-	-
4	212 (30,2%)	-	-	-	-
5	81 (11,5%)	-	-	-	-
Quantity (1-5)	-	3,24	1,06	-0,02	-0,68
1	28 (4,0%)	-	-	-	-
2	150 (21,4%)	-	-	-	-
3	243 (34,6%)	-	-	-	-
4	188 (26,8%)	-	-	-	-
5	93 (13,2%)	-	-	-	-
Distance (1-4)	-	2,76	0,93	-0,29	-0,78
>5km	73 (10,4%)	-	-	-	-
1km a 5km	187 (26,6%)	-	-	-	-
300m a 1km	275 (39,2%)	-	-	-	-
<300m	167 (23,8%)	-	-	-	-

Note. SD = Standard Deviation; S = Skewness; K = Kurtosis.

Figure 20

Overall result of the main study variables



Note. Average of the results converted into percentages

In terms of the type of study pursued by the students, divided into the 5 official branches, similar results have been found for most variables. It is necessary to highlight some exceptions, such as lower scores on the GSs characteristics reported in Arts and Humanities and higher levels of health in Health Sciences. More details of these data are provided in Table 10 and Figure 21.

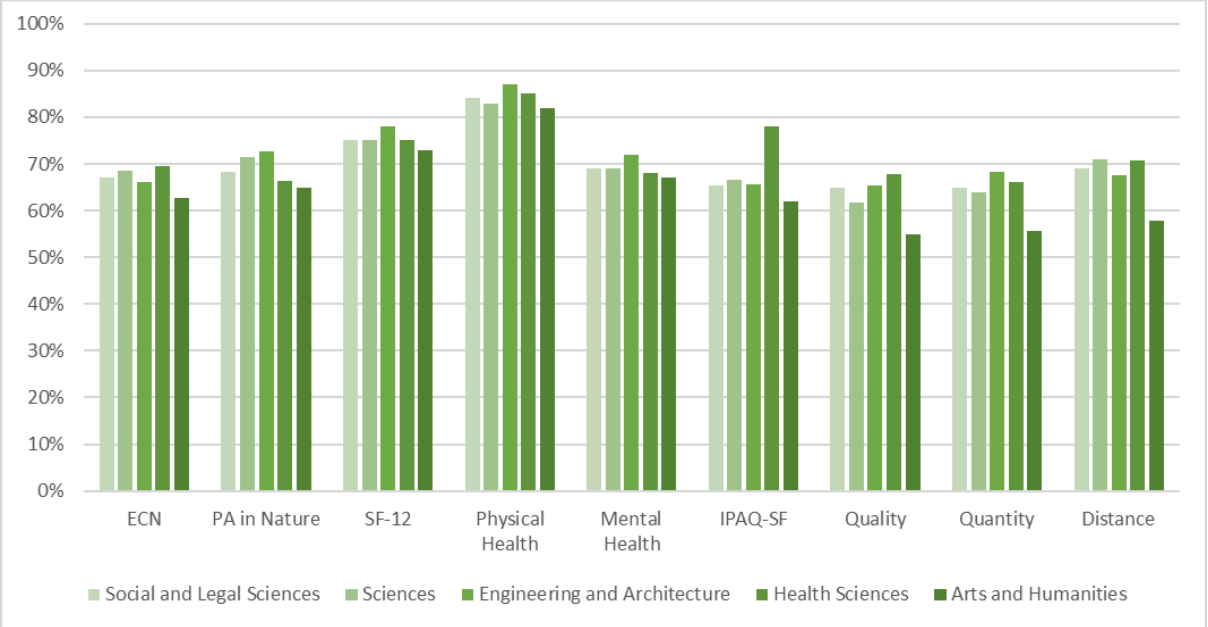
Table 10. Overall outcome of the main study variables and type of study pursued

	Distance	Quality	Quantity	PA in nature	ECN	Mental Health	Physical Health	SF-12	IPAQ-SF	Sitting hours
Social and Legal Sciences	2,76 (0,93)	3,24 (1,04)	3,24 (1,06)	3,42 (1,16)	3,36 (0,83)	0,69 (0,15)	0,84 (0,16)	0,75 (0,14)	1,96 (0,45)	5,67 (1,17)
Sciences	2,84 (0,84)	3,09 (1,10)	3,20 (1,09)	3,57 (1,05)	3,43 (0,96)	0,69 (0,16)	0,83 (0,17)	0,75 (0,14)	2,00 (0,40)	5,66 (1,06)
Engineering and Architecture	2,70 (0,82)	3,27 (1,10)	3,42 (1,21)	3,63 (1,15)	3,31 (0,85)	0,72 (0,15)	0,87 (0,12)	0,78 (0,13)	1,97 (0,43)	5,48 (1,05)
Health Sciences	2,83 (0,99)	3,39 (0,98)	3,31 (1,01)	3,32 (1,21)	3,47 (0,80)	0,68 (0,16)	0,85 (0,14)	0,75 (0,13)	2,34 (0,62)	5,22 (1,95)
Arts and Humanities	2,31 (0,82)	2,75 (1,00)	2,78 (1,07)	3,25 (1,08)	3,13 (0,89)	0,67 (0,14)	0,82 (0,18)	0,73 (0,14)	1,86 (0,49)	5,81 (1,10)

Note. Averages (Standard Deviations)

Figure 21

Overall results of the main study variables and type of study pursued



Note. Averages of the results converted into percentages

In the statistical analysis, the data show a strong correlation between all main variables (CN, health, PA, PA in nature and characteristics of GSs). The only variable that is not correlated with all of them is the number of sitting hours, which is not related to distance and the amount of GSs and PA in nature. The Pearson correlations are shown in the following table (Table 11).

Table 11. Pearson's correlation coefficients between the main study variables

	Distance	Quality	Quantity	PA in nature	ECN	Mental Health	Physical Health	SF-12	IPAQ-SF	Sitting hours
Distance	-	.461***	.445***	.314***	.432***	.275***	.271***	.309***	.228***	-.031
Quality	.461***	-	.634***	.360***	.539***	-284***	.276***	.317***	.281***	-.075*
Quantity	.445***	.634***	-	.352***	.515***	.256***	.191***	.264***	.239***	-.073
PA in nature	.314***	.360***	.352***	-	.787***	.440***	.440***	.496***	.154***	-.045
ECN	.432***	.539***	.515***	.787***	-	.454***	.451***	.510***	.302***	-.079*
Mental Health	.275***	.284***	.260***	.440***	.454***	-	.547***	.934***	.258***	-.121**
Physical Health	.271***	.276***	.191***	.440***	.451***	.547***	-	.810***	.293***	-.200**

SF-12	.309***	.317***	.264***	.496***	.510***	.934***	.810***	-	.306***	-.136***
IPAQ-SF	.228***	.281***	.239***	.154***	.302***	.258***	.293***	.306***	-	-1.44***
Sitting hours	-.031	-.075*	-.073	-.045	-.079*	-.122**	-.120**	-.136***	-1.44***	-

Note. *p<.05; **p<.01; ***p<.001

4.2.2.3. Secondary Variables

Regarding the correlations between the main variables and the secondary variables (academic, socio-demographic and personal), it has been found differences between the different genders in the research, as women obtained greater significant relationships with all the other variables, except for the distance to GSs. Furthermore, age is related to CN, quality and quantity of GSs and the fact of having a disability is related to health, CN and PA performed in nature.

When it comes to the socio-demographic variables, the data show relationships between a higher socio-economic level and all the other variables, which are also related to one another; the same happens with being federated in a sport. In addition, Spanish students are associated with a bigger amount of GSs available near their place of residence. In terms of employment status, students who are actively working are associated with a shorter distance to GSs, greater CN and PA in nature, and higher level of health.

Finally, at the academic level, it has been found that the higher the level of study, the better the reported characteristics of the GSs. Participation in an exchange program is related to the level of PA and, as regards the modality of study, the fact of studying in a face-to-face environment is related to the distance and the quality of the GSs. All these correlations are reflected in the following table (Table 12).

Table 12. Spearman correlation coefficients between the main study variables and the secondary variables

	Distance	**Quality**	**Quantity**	**PA in nature**	**ECN**	**Mental Health**	**Physical Health**	**SF-12**	**IPAQ SF**	**Sitting hours**
Sex	-.067	-.122*	-.090*	-.113*	-.110*	-.135*	-.075*	-.134*	-.239*	.170*
Age	.048	.093*	.127*	.073	.099*	-.039	-.335	-.040	-.065	.040
Socioeconomic level	.314*	.296*	.312*	.262*	.303*	.310*	.231*	.316*	.182*	-.164*
Work Status	-.115*	-.061	-.012	-.121*	-.102*	-.257*	-.093*	-.229*	-.051	-.004

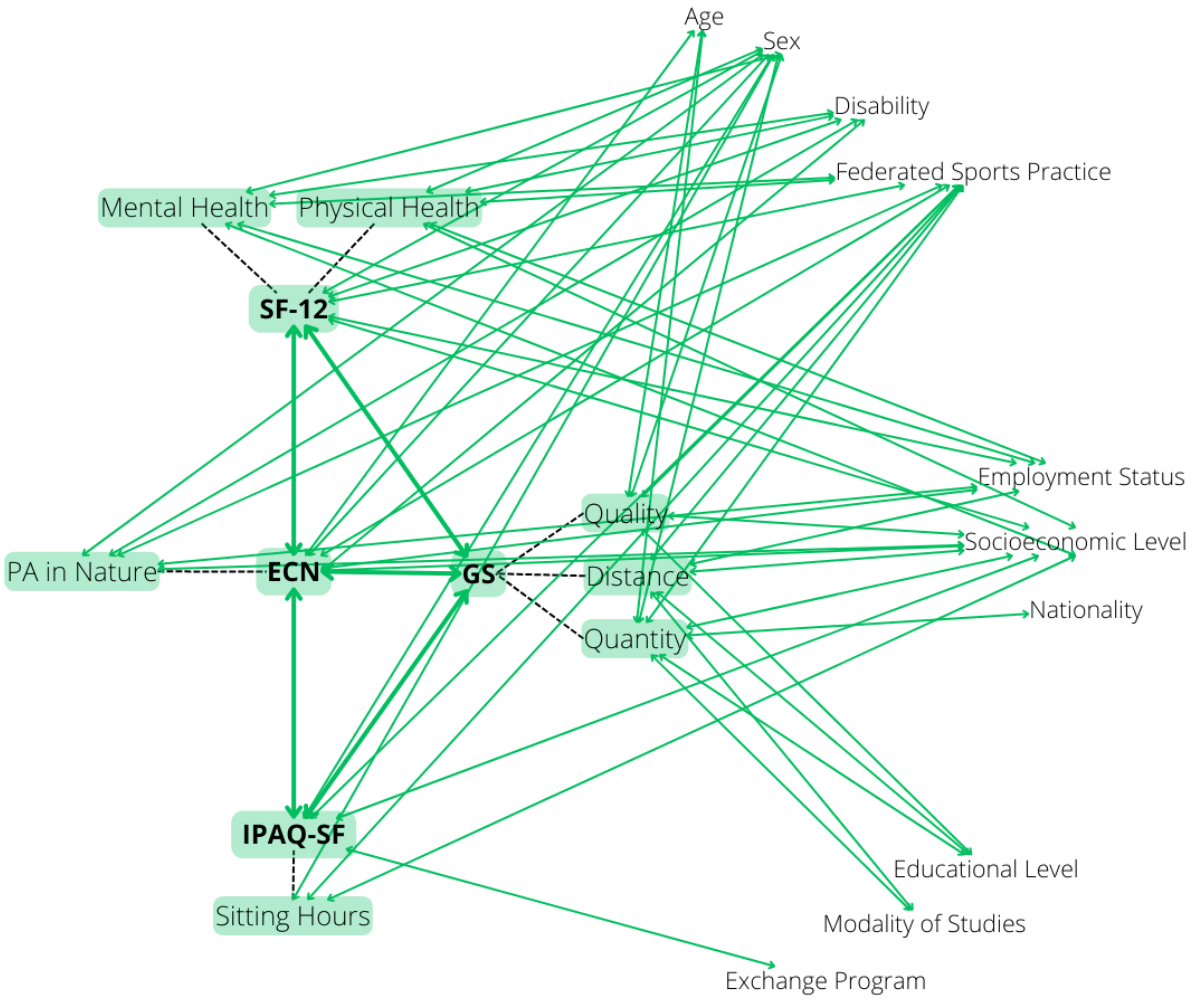
Nationality	.064	.073	.076*	.063	.049	.006	-.001	.006	-.012	.068
Disability	.006	-.028	.033	-.126*	-.097*	-.090*	-.198*	-.153*	-.035	.067
Federated Sports	.107*	.218*	.154*	.243*	.272*	.278*	.265*	.301*	.316*	-.113*
Education Level	.111*	.112*	.152*	.025	.056	-.060	-.045	-.060	-.067	-.031
Exchange Program	.025	.022	.038	-.052	-.029	-.052	-.012	-.041	.078*	.003
Modality of Studies	-.101*	-.072	-.094*	-.022	-.067	-.228	-.029	-.033	-.024	.070

Note. *p<.05

Finally, as a visual summary, all of the above correlations are presented in a single graph (Figure 22).

Figure 22

Visual layout of the variables correlations of the observational study



4.2.2.4. Results of the questionnaire by communities

Due to the low parity and the small sample size between the different communities, it is not possible to statistically analyze the data to get acceptable results. Therefore, it is possible to present only one table (Table 13) of the results of the main variables by community.

Table 13. General result of the main variables by communities

Community	ECN	PA in nature	SF-12	Physical Health	Mental Health	IPAQ SF	Sitting hours	Quality	Quantity	Distance
Andalusía	3,50	3,66	0,79	0,91	0,72	2,13	6,10	3,28	3,17	2,43
Aragon	3,81	4,14	0,85	0,97	0,77	2,17	5,72	3,42	3,08	2,94
Balearic Islands	3,70	3,73	0,73	0,83	0,66	2,13	5,80	4,07	4,13	3,53
Canary Islands	3,85	3,92	0,79	0,90	0,72	1,92	6,00	3,69	3,58	3,12
Cantabria	3,71	3,88	0,81	0,90	0,75	2,00	5,41	3,35	3,24	2,65
Castile-La Mancha	3,45	4,00	0,80	0,89	0,74	2,00	5,86	3,43	3,43	2,86
Castile and León	3,50	3,71	0,79	0,87	0,73	2,03	5,54	3,06	3,26	2,80
Catalonia	3,34	3,69	0,79	0,88	0,74	1,95	5,45	2,74	2,66	2,62
Community of Madrid	3,18	3,56	0,77	0,86	0,72	1,79	5,34	2,67	2,85	2,43
Foral Community of Navarra	3,12	3,14	0,68	0,77	0,63	1,83	5,83	3,06	3,34	2,89
Valencian Community	3,40	3,04	0,73	0,84	0,66	2,50	4,90	3,47	3,31	2,83
Extremadura	3,21	3,12	0,70	0,78	0,64	2,12	5,54	3,08	3,69	2,88
Galicia	3,25	3,03	0,70	0,80	0,63	2,03	5,65	3,74	3,55	2,90
Basque Country	3,27	3,38	0,68	0,79	0,61	2,00	5,63	3,13	3,38	2,63
Principality of Asturias	3,42	3,58	0,68	0,77	0,63	2,08	5,92	3,44	3,69	2,72
Region of Murcia	3,57	3,42	0,75	0,83	0,70	2,67	5,04	3,08	3,04	3,04
La Rioja	3,24	3,25	0,70	0,80	0,63	1,92	6,00	3,25	3,42	2,58

Note. Average results

4.2.3. Models of causal relationships

A path analysis was performed in Mplus 8.7 (Muthén & Muthén, 2017) to test the hypothesized model and the role of nature exposure in the relationship between GSs, PA and physical/mental health indicators among Spanish students. The parameter maximum likelihood estimation (MLE) and bootstrapping (1000 simulations) was performed to estimate indirect effects. Model fit was assessed using the $\chi 2$/gl ratio, with values up to 3 indicating acceptable fit, the comparative fit index (CFI) and the Tucker-Lewis index, with values above 0.90 indicating acceptable fit, and the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR), with values <.08 indicating acceptable fit.

The fit indices of the tested model (Figure 23) were as follows: $\chi 2$= 35.51; gl = 9; p=.000; CFI = 0.970; ILI = 0.941; RMSEA = 0.065 (0.043, 0.088 90% CI); SRMR = 0.037. This indicated an acceptable fit of the model to the data for all parameters except the chi-square value. After adding a regression path from the quality of the GSs to the PA suggested by the modification indices, the program suggested no further modification indices and the model fit indices were as follows: $\chi 2$ = 20.08; gl = 8; p=.010; CFI = 0.987; ILI = 0.970; RMSEA = 0.046 (0.021, 0.072 90% CI); SRMR = 0.023. Thus, the model showed a very good fit to the data. The resulting standardized parameter estimates are shown in Figure 24 (STDYX standardization).

Figure 23

Visualization of the proposed model of relationships between green space indicators, contact with nature, physical activity and health

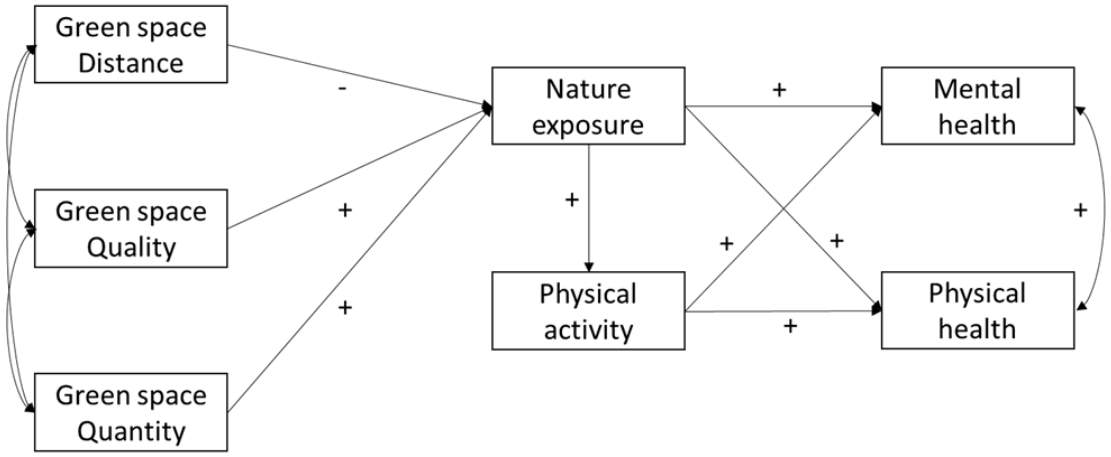
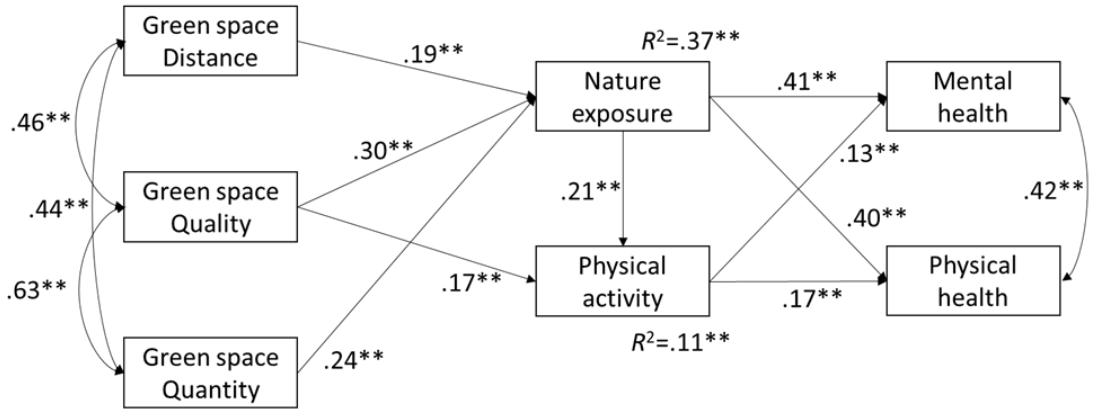


Figure 24

Main features of the Spanish model (STDYX standardization)



Note. **p<.01

All mediations shown, i.e. indirect relationships, are significant at least at the 95% significance level, as can be seen from the bootstrap confidence intervals excluding the zero value, that is excluding negative and positive values, in Table 14. When considering the mediating role of CN between GSs, PA and health indicators, it was found that higher levels of GSs characteristics predicted higher levels of health and PA through higher degrees of CN, based on the results provided by students in Spain.

Table 14. Non-standardised estimates of indirect effects for the Spanish sample

Indirect Effects	NSE of indirect effect	95% CR (k=1000)	99% CR (k=1000)
GSs Distance → CN→ PA	0.024	0.012; 0.043	0.009; 0.052
GSs Quality → CN → PA	0.035	0.018; 0.057	0.014; 0.063
GSs Quantity → CN → PA	0.028	0.015; 0.044	0.011; 0.049
GSs Distance → CN → Mental Health	0.013	0.008; 0.020	0.006; 0.022
GSs Quality → CN → Mental Health	0.018	0.012; 0.025	0.010; 0.027
GSs Quantity → CN → Mental Health	0.015	0.010; 0.021	0.008; 0.023
GSs Quality → PA → Mental Health	0.003	0.001; 0.007	0.001; 0.008
GSs Distance → CN → PA → Mental Health	0.001	0.000; 0.002	0.000; 0.003
GSs Quality → CN → PA → Mental Health	0.001	0.000; 0.002	0.000; 0.003
GSs Quantity → CN → PA → Mental Health	0.001	0.000; 0.002	0.000; 0.002
GSs Distance → CN → Physical Health	0.012	0.007; 0.019	0.005; 0.021

GSs Quality → CN → Physical Health	0.017	0.011; 0.023	0.010; 0.025
GSs Quantity → CN → Physical Health	0.014	0.009; 0.019	0.007; 0.021
GSs Quality → PA → Physical Health	0.004	0.001; 0.008	0.001; 0.009
GSs Distance → CN → PA → Physical Health	0.001	0.000; 0.002	0.000; 0.003
GSs Quality → CN → PA → Physical Health	0.001	0.000; 0.003	0.000; 0.003
GSs Quantity → CN → PA → Physical Health	0.001	0.001; 0.002	0.000; 0.002

Note. NSE = Non-standardized effects; CI = confidence interval; k = amount of simulations / *bootstrapped* samples

4.3. Discussion

This research presents interesting data on the nature-human relationship in the field of health, PA and the university stage. It does not only demonstrate the benefits the natural environment can provide, which are well known and explained in the theoretical framework, but also focuses on how this environment facilitates these effects, in this case in a specific population, university students. On the basis of the results provided, it can be engaged in a detailed discussion about the relationships and patterns observed in the research.

The data not only supports but emphasizes the critical role of CN in shaping the health and PA levels of university students. The strong association between GS characteristics and health outcomes through CN highlights the significance of incorporating nature exposure into health-promoting interventions.

The confirmed relationships between CN, health status, and PA levels underscore the holistic nature of well-being. Students reporting higher CN not only exhibits better physical health of this population but they are also more likely to engage in regular PA . This suggests that interventions aimed at enhancing CN could have far-reaching benefits on both mental and physical health.

The results show that all the main variables are related to one another. This suggests a significant relationship between factors such as CN, GS characteristics, PA and health (Li et al., 2022; Stangierska et al., 2023). Nevertheless, it is interesting to highlight that sitting hours are not significantly correlated with the characteristics of the natural environment, but they are significantly correlated with health and PA, suggesting that this variable greatly depends on individual circumstances and may not directly be related to other aspects studied (Garn & Simonton, 2023). For this reason, this whole relationship may be a mixture of the biophilia hypothesis (Ulrich, 1993), which suggests that people prefer to be surrounded by plants and

feel better in a natural environment, and conditioning theory (Egner et al., 2020), where individuals associate the natural environment with positive effects due to personal circumstances.

The study's findings regarding the impact of GS characteristics on CN, health, and PA levels provide actionable insights for urban planning and public health initiatives. Proximity, quality, and quantity of GSs play pivotal roles in shaping students' well-being. Interventions focusing on improving accessibility and quality of nearby GS may have positive implications for the health and PA behaviors of the student population.

There have also been found gender differences in this study. Despite the lower female participation in completing the questionnaire, the trend is that university women show significant relationships with most of the variables studied, suggesting that they may have a greater sensitivity or interest in issues related to the environment, sports and health compared to men. The exception in distance from nature may reflect gender differences in the perception and value attached to the natural environment, although this does not detract from the benefits of the natural environment itself, as research such as the one conducted by Teixeira et al. (2023) has found that women who have GSs close to their homes maintain better health.

The results also show that age is positively associated with CN, quality and quantity of GSs, and so is the education level. This may suggest that as students mature, they develop a greater appreciation for nature and become more aware of its importance for their well-being. It has also been shown that childhood experiences in nature have an impact on forms of entertainment in adulthood, which favors the possibility of reconnecting with nature at later stages (Lee & Burns, 2022), although this parameter was not analyzed.

The gender and age differences in the relationships with various variables highlight the need for tailored interventions based on demographic characteristics. Women's stronger associations with these factors suggest that strategies promoting nature exposure and physical activity might be particularly beneficial for female students. Additionally, the age-related variations emphasize the evolving nature of these relationships and the importance of considering developmental stages in intervention planning.

The data also indicate that the higher the socioeconomic level, the easier the positive integration of all variables (health, PA, etc.) in the same way as it is being federated in a concrete sport. This suggests that the social gap has implications at the level of well-being and access to nature. Likewise, students that are actively employed enjoy better health and

are more exposed to nature, which could indicate why this population could be more aware of their health status and the environment around them.

As for disability, it seems to be associated with lower CN and less PA practiced in nature. This relationship could be influenced by the lack of accessibility to urban parks and GSs, which limits opportunities for people with disabilities to enjoy nature and outdoor PA (Piskin & Akdeniz, 2023).

At the academic level, the data suggest that the exchange program is positively associated with PA. This finding may be related to the fact that people who participate in exchange programs tend to be more active and engage in physical activity while exploring a new environment. In addition, living in a foreign place may motivate people to try sports and activities that they might not have considered at home. This finding highlights the positive impact that international experience can have on students' levels of PA and, therefore, on their overall health (Omar-Fauzee et al., 1999).

Research also suggests that face-to-face study is associated with shorter distance and bigger quantity in relation to GSs. This suggests that people who attend classes in person are more aware of the existence of these natural areas in their environment and have easier access to them. Physical presence at a university campus or in a traditional educational setting could increase the likelihood of students to interact with GSs in their everyday lives. This finding highlights the importance of the location and design of university campuses in promoting interaction with nature and student health (Liu et al., 2022).

The field of study does not seem to affect most of the variables to a great extent, except for PA, where Health Science students participate more compared to students from other fields; the reason behind this could be that their studies help them to be more aware of the benefits of a healthy lifestyle. On the other hand, Arts and Humanities students reported poorer GSs characteristics, which may be related to the nature of their studies. Currently, there is not much evidence available that develops such themes and compares different university branches (Chumbe, 2021), plus what was observed in this research, therefore this would be an aspect to consider in future research.

Finally, the results highlight the importance of the characteristics of the GSs, as they can be conditioning factors of the other variables, including the CN. This suggests that it is essential to maintain and improve the access and quality of urban GSs in order to foster a connection with nature and improve the health and well-being of the population (Carrus et al., 2017; Hunter et al., 2015).

In summary, these findings provide valuable insights into how different factors, such as gender, age, disability or type of study, are associated with GSs, PA and health in university settings. These findings may be useful in designing policies and programs to promote healthier and more sustainable lifestyles among students, taking into account individual differences and the importance of GSs in our communities.

4.4. Limitations

This research presents some limitations, especially when it comes to the participants in the study. While it would have been ideal to have a larger and more representative sample of students, it would have been particularly interesting to have a greater diversity of participants in all aspects (gender, type of study, location, etc.) There might have been many reasons behind this, but it is believed that it was mainly due to the timing of the data collection, which took place at the end of the academic year, i.e. the evaluation period and summer, i.e. the holiday period, when students might have not been as receptive to answering the questionnaire.

In this sense, future research should take this issue into account when recruiting participants for similar studies. Finally, another important limitation is the fact that this is a non-experimental cross-sectional study, which does not allow conclusions to be drawn about causal relationships between the variables studied.

Chapter 5: OBSERVATIONAL STUDY II - International Comparison

5.1. Methodological Design

This study is an extension of the UCV/2021-2022/118 project, whose ethics committee of the Catholic University of Valencia can be seen in Annex 3.3. The objective of this study is to allow the use of the data obtained in the main project for comparison with data from Croatian students.

This study was born with the idea of comparing the variables observed in the main study in an international context. Current data shows that sedentary lifestyles and obesity rates are getting worse. For example, in the 2020 European Health Survey, at the Spanish level, 46.5% of men and 54.8% of women declared not devoting any day to physical exercise in their free time and that lifestyle has a negative impact on both quality of life and health and life expectancy (Anstey et al., 2014; Lee et al., 2012). While in Croatia, according to data collected in 2015 by the World Health Observatory (WHO), 80.2% of the adult population is physically active, 83.2% of men and 77.5% of women reach activity levels recommended for health. By carrying out an international comparison it can be determined which countries (according to the scale of the project in question), with their defined sociocultural context, are more likely to favor a positive environment in terms of health, environment and quality of life.

In this section, a Spanish and Croatian university sample was compared to examine the potential contribution of GSs characteristics and CN to PA practice and health levels. In this context, CN was examined as a possible mediator in the relationship between GSs characteristics, PA and health status. Finally, cross-country differences in the variables examined have been looked at according to the characteristics of each sample and the characteristics of the reported GSs (e.g. to see if any of them reported less distance) and examined potential differences and similarities in order to draw relevant conclusions.

Regarding the calculation of the sample size for the study, no similar study was found to compare data, and the same formula was used as for the original study ($n = Z^2 * (p) * (1-p) / E^2$). A population of approximately 150,000 (number of university students in Croatia) was taken into account giving a result of 384 subjects, added to the necessary subjects in the Spanish group.

For this research, data were collected from a convenience sample of 240 university students, half Spanish and half Croatian, with an average age of 22 years. Participants gave their written consent in the study questionnaire itself, which was approved by the ethics committee of the two main universities involved, the Catholic University of Valencia (Spain) and the University of Zadar (Croatia). To collect data from Croatian students, a project was requested from the ethics committee of the University of Zadar (16-22-01), which can be seen in Annex 3.4.

The methodology used was similar to that of the Spanish sample study (part of which was used for this comparison). It involved online contact with a number of Croatian universities that agreed to distribute the original questionnaire translated into English, together with the validated questionnaires in their English version, through social networking platforms, so that students could respond freely. In this sense, it should also be noted that this research was born with the idea of being able to analyze the possible differences between one country and another in areas such as health, nature and PA in the university world.

For this survey, the same questionnaire as the original study was used, which included main variables such as exposure to nature measured with the Nature Exposure Scale II (NES-II) (Wood et al., 2019), physical activity levels being assessed with the International Physical Activity Questionnaire - Short Form (IPAQ-SF) (Rodríguez-Muñoz et al., 2017) and health status measured using the Short Form-12 (SF-12) questionnaire (Vera-Villarroel et al., 2014). In addition, the distance (Toftager et al., 2011), quality (Nguyen et al., 2021) and quantity (Ruijsbroek et al., 2017) of GS were evaluated with specific questions for each characteristic in the designed Ad Hoc Questionnaire. Questions were also included about age, gender, nationality, geographical area, socioeconomic level, employment status, disability and percentage of disability, federated sports practice, level of education, type of studies currently being taken, participation in the exchange program ERASMUS or other similar ones, and finally, the study modality.

For the statistical analysis of the objectives of the study, a descriptive analysis of the sample was first performed. Means, frequency, variance, and indices of the shape of the distribution of the study variables were calculated. Welch's t-tests and t-tests were performed to examine the differences in the study variables between countries and Pearson's coefficients were calculated to study the correlations between the variables in each country.

Finally, corresponding models were run and estimated through a multigroup path analysis to examine the proposed mediating role of nature exposure in the relationship between GS characteristics and PA and health. Differences among the model relationships

across countries were also examined with Chi-square difference tests comparing the final model and models with equality constraints of individual path coefficients. The Statistica™ 14 package was used for data analysis and Mplus 8.7 to perform the path analysis.

5.1.1. Procedure

This research study was designed in a similar way to the main study of the thesis, as a cross-sectional study and was divided into two well-defined parts: data collection and data analysis. First of all, to obtain the data, the principal investigator contacted the University of Zadar and the Catholic University of Valencia to present them the study.

Participants were required to complete an online Google form with the study survey, which included the Participant Information Sheet and the Informed Consent. The survey was delivered personally to Spanish students during classes, and as for the Croatian students, the survey was distributed through email and shared on Facebook groups. The recruitment of Croatian students was carried out during the months of October to December 2023 coinciding with the international stay of the author of the dissertation. The final sample consisted of 120 Spanish university students and 120 Croatian university students.

Once the data was obtained, the principal investigator was responsible for its analysis and, therefore, the deduction of the relevant conclusions. The results were analyzed in an aggregate manner and never individually, following a data protection plan that took into account current legislation in this regard.

5.2. Results of the comparison

The key observations derived from the international comparative study that focuses on the assessment of university students in two different countries will be presented. The results offer an overview of the similarities and differences between the two countries, providing a broader understanding of the factors that influence student life and higher education in health and nature contexts.

5.2.1. Participants

The study involved a diverse participant pool, including individuals from Spain, Croatia, and the combined total of both countries. The average age across the entire cohort was 22 years, with both the Spanish and Croatian subgroups exhibiting similar mean ages of 22 and 21 years, respectively. Gender distribution revealed 114 males and 126 females in the

total sample, constituting 47.4% and 52.6%, respectively, with the Spanish subgroup comprising 94 females and 26 males, and the Croatian subgroup consisting of 20 males and 100 females.

Regarding disability, the majority reported no disability (234), representing 97.5% of the total sample, with the Spanish subgroup consisting of 116 individuals without disabilities and the Croatian subgroup comprising 118 individuals, each with detailed levels of disability (1 to 5). Involvement in federated sports varied, with 66 participants in the total sample (27.5%), 41 in the Spanish subgroup, and 25 in the Croatian subgroup.

Educational attainment varied, with 196 participants holding a Bachelor's degree (81.7%), 33 with a Master's degree (13.8%), 4 with a PhD (1.7%), and 7 with other qualifications (2.9%). The total sample encompassed 34 different types of study, with the Spanish and Croatian subgroups participating in 9 and 25 types, respectively. Modalities of study were predominantly face-to-face (225), constituting 93.8%, with a smaller portion opting for online studies (15). A subset of participants engaged in exchange programs (5), with representation from three Spanish and two Croatian individuals.

Participants hailed from various nationalities, including Spanish, Croatian, Albanese, Romanian, Chilean, and Colombian. The places of residence varied, totaling 81 in the overall sample, 54 in Spain, and 27 in Croatia.

Socioeconomic status was categorized as low, medium, and high, with the majority (86.3%) falling into the medium category (207 individuals from the total sample, 103 in the Spanish subgroup, and 104 in the Croatian subgroup). Active work status was reported by 63 individuals in the total sample (26.3%), with 42 in the Spanish subgroup and 21 in the Croatian subgroup.

These demographic and socio-economic characteristics provide a comprehensive profile of the study population, facilitating a nuanced analysis of potential influences on the observed outcomes. Finally, the following table (Table 15) presents a comprehensive overview of various demographic and socio-economic parameters characterizing the sampled population.

Table 15. General parameters from both countries

Variables	Total	Spain	Croatia
Age *(Average)*	22	22	21
Sex			
Male	114	94	20
Female	126	26	100
Disability			
No disability	234	116	118
Level 1	1	1	0
Level 2	2	2	0
Level 3	0	0	0
Level 4	0	0	0
Level 5	3	1	2
Federated Sports	66	41	25
No. of Institutions	15	7	8
Education Level			
Bachelor's degree	196	110	86
Master's	33	6	27
PhD	4	4	0
Others	7		7
No. of Types of Study	34	9	25
Modality of Studies			
Face-to-face	225	107	118
Online	15	13	2
Exchange Program	5	3	2
No. of Nationalities			
Spanish	-	116	-
Croatian	-	-	119
Albanese	1	-	1
Romanian	2	2	-
Chilean	1	1	-
Colombian	1	1	-
No. of Places of Residence	81	54	27
Socioeconomic Level			
Low	16	7	9
Medium	207	103	104
High	17	10	7
Active Work Status	63	42	21

5.2.2. Main Variables

Once all the data of both countries was obtained, a descriptive analysis of the main variables of the study was carried out, as shown in Table 16. As it can be seen from the data presented, the PA variable was divided into two sub-categories, one with the calculation of Mets and the other with the three categories of PA mentioned above. It has been decided to use this variable because the skewness and kurtosis of PA are not acceptable for parametric analyses in the calculation of Mets, but they are acceptable in the PA category variable (the same was true in the main study with the Spanish sample).

Table 16. Descriptive statistics of the variables from both countries

	Spain					Croatia				
	M	***DS***	**Range**	**S**	**K**	***M***	***DS***	**Range**	**S**	**K**
NES-II	3.50	0.75	(1.5-5.0)	-0.03	-0.53	3.33	0.77	(1.33-5)	-0.16	-0.1
PA in nature	3.13	1.23	(1-5)	-0.20	-0.87	3.03	1.27	(1.00-5)	-0.19	-0.98
SF-12	71.00	14.10	(25.00-97.22)	-0.32	-0.04	64.44	15.91	(16.67-91.67)	-0.33	-0.40
IPAQ-SF										
METS	4117	4007	(139-24939)	2.39	7.86	2230	2531	(0-17724)	3.03	12.89
PA Category	2.47	0.61	(1-3)	-0.67	-0.48	2	0.66	(1-3)	-0.00	-0.67
Green Spaces										
Quality	3.44	1.03	(1-5)	-0.17	-0.41	3.43	1.01	(1-5)	-0.11	-0.71
Quantity	3.27	1.05	(1-5)	0.15	-0.72	3.45	1.00	(1-5)	-0.19	-0.68
Distance	2.07	1.05	(1-4)	0.57	-0.91	1.64	0.76	(1-4)	0.94	0.13

Note. S = Skewness; K = Kurtosis. PA category is the variable of the three categories where 1 is low, 2 is moderate and 3 is high.

Table 17 shows the results of the T-tests and Welch's test to compare and examine the differences between the two countries and Figure 25 shows the average data. The results show that students in Croatia have a shorter distance to GSs than students in Spain, while students in Spain reported a higher level of PA and health than students in Croatia. There are no other significant differences between the countries when considering these main variables.

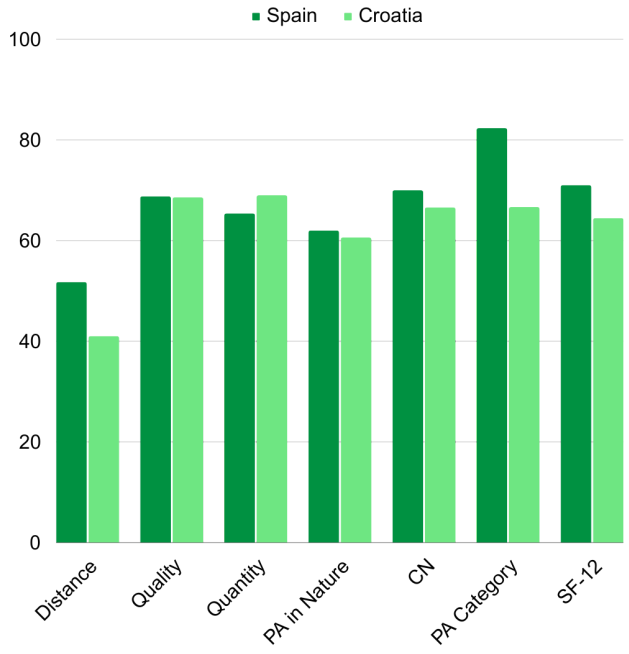
Table 17. T-tests and Welch's t-tests to examine differences between countries on key variables

Variable	*A* SP	*A* CR	*SD* SP	*SD* CR	*t*	*df*	*p*	*t* separ. var.est.	*df*	*p* 2-sided	Levene *F* (1,df)	*df* Levene	*p* Levene
Distance	2.07	1.64	1.05	0.76	3.58	238	.000	3.58	217.41	.000	9.02	238	.003
Quality	3.44	3.43	1.03	1.01	0.06	238	.950	0.06	237.93	.950	0.00	238	.970
Quantity	3.27	3.45	1.05	1.00	-1,38	238	.168	-1.38	237.48	.168	0.01	238	.916
PA in nature	3.10	3.03	1.23	1.27	0.62	238	.526	0.62	237.75	.536	0.04	238	.849
CN	3.50	3.33	0.75	0.77	1.69	238	.091	1.69	237.90	.091	0.00	238	.961
METS	4117	229	4008	2531	4.36	238	.000	4.36	200.91	.000	12.65	238	.000
PA Category	2.47	2.00	0.61	0.66	5.70	238	.000	5.70	236.30	.000	6.42	238	.012
SF-12	71.00	64.44	14.10	15.91	3.38	238	.001	3.38	234.60	.001	2.62	238	.107

Note. ASP = Average Spain; ACR = Average Croatia; SDSP = Standard Deviation Spain; SDCR = Standard Deviation Croatia.

Figure 25

Overall result of the main study variables from both countries



Note. Average of the results converted into percentages

Pearson's correlation coefficients for the different variables are shown in Table 18. Both quality and quantity of GSs are correlated with shorter distance of GSs in both countries, indicating that they are perceived to be of bigger quantity and higher quality the closer they are to the students' place of residence. In both countries, quality and quantity of

GSs have relatively high positive correlations; the bigger the quantity, the higher the quality. CN is positively correlated with the quality and quantity of GSs for Croatian students, but only with the quantity of GSs for Spanish students. Therefore, CN is not correlated with distance to GSs for either group of students.

The analysis shows a high correlation between CN and PA performed in nature, suggesting that PA in nature could be partly mediated by the CN variable. PA in Spain is not correlated with any of these variables and PA in Croatia is positively correlated with health and no other variables. Three-level PA in Croatia is also correlated with health, but also with CN and PA in nature. Health is correlated with CN for both Croatian and Spanish students. Health is not correlated with any other variable in Croatia. In Spain, better health is also correlated with higher quality and bigger quantity of GSs and shorter distance to GSs, as well as it is correlated with PA practiced in nature.

Table 18. Pearson's correlation coefficients between the main variables in Spain (above the diagonal) and Croatia (below the diagonal)

Variable	Distance	Quality	Quantity	PA in nature	CN	METS	PA Category	SF-12
Distance	-	-.308**	-.305**	-.013	-.106	.056	.017	-.201*
Quality	-.385***	-	.637***	.046	.110	-.004	-.091	.183*
Quantity	-.347***	.644***	-	.219*	.271**	-.003	-.078	.235*
PA in nature	-.066	.139	.094	-	.752***	.124	.096	.282**
CN	-.083	.353***	.194*	.764***	-	.145	.138	.399***
METS	.000	-.064	-.048	.087	.080	-	.599***	.159
PA Category	-.017	-.076	-.139	.210*	.270**	.719***	-	.127
SF-12	.072	.114	.091	.171	.254**	.233*	.300**	-

Note. *p<.05; **p<.01; ***p<.001

5.2.3. Secondary Variables

Table 19 shows the correlations between the socio-demographic variables and the main study variables for the whole sample. These correlations have been examined to allow for possible interpretations and explanations of the relationships between the study variables, taking into account the different socio-demographic characteristics between countries.

The data show that the higher the socio-economic status, the more GSs are available. Similarly, people who are federated in sports report higher levels of PA. In terms of age, although there are few differences in the examined sample, the older the person, the less PA they practice. In terms of gender, women are less likely to engage in PA and report lower levels of health than men.

Table 19. Pearson's correlation coefficients between socio-demographic variables and the main study variables in the whole sample

Variable	Sex	Age	Socioeconomic Level	Work Status	Disability	Federated Sports
Sex	-	-.086	-.011	-.153*	-.007	-.162*
Age	-.086	-	-.054	.249***	.003	-.104
Socioeconomic Level	.011	-.054	-	.044	.017	.069
Work Status	-.153*	.249***	.044	-	.028	.120
Disability	-.007	.003	.018	.028	-	-.008
Federated Sports	-.162*	-.104	-.067	.120	-.008	-
Distance	-.148*	-.027	-.010	.072	.030	.086
Quality	.081	-.019	.050	.013	-.033	-.082
Quantity	.112	-.010	.149*	-.033	.006	-.133*
PA in nature	-.078	-.019	-.064	.044	-.078	.041
CN	.004	-.002	-.018	.057	-.105	.084
METS	-.169**	-.077	.002	.079	.083	.190**
PA Category	-.228***	-.162*	.029	.117	.003	.300***
SF-12	-.241***	-.050	-.013	.016	-.063	.086

Note. *p<.05; **p<.01; ***p<.001

5.2.4. Models of causal relationships

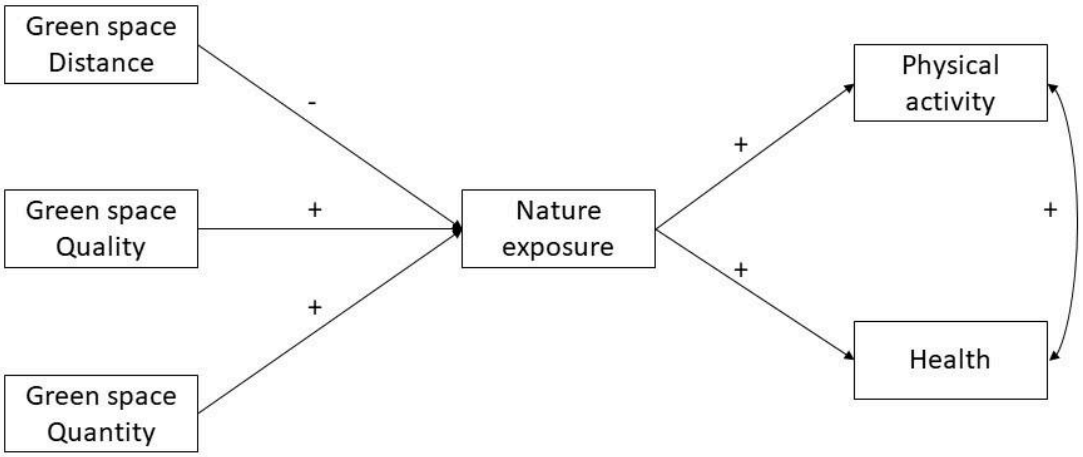
To test the hypothesized model and the role of exposure to nature in the relationship between GSs, PA and health indicators in the group of students in Spain and Croatia, a multigroup path analysis was performed in the Mplus 8.7 program (Muthén & Muthén, 2017). The maximum likelihood (ML) parameter estimation method was used and bootstrapping was performed (1000 simulations). Model fit was examined using the $\chi 2/df$

ratio, with values up to 5 indicating acceptable fit, the comparative fit index (CFI) and the Tucker-Lewis index, with values above 0.90 indicating acceptable fit, and the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR), with values <.08 indicating acceptable fit.

The fit indices of the tested model (Figure 26) were as follows: $\chi 2$= 18.467 (chi-squared contribution of each group: Spain: 7.600; Croatia: 10.867); gl = 12; p=.102; CFI = 0.907; ILI = 0.814; RMSEA = 0.067 (0.000; 0.124 C.I. 90%); SRMR = 0.067. This indicated an acceptable fit of the model to the data for all parameters except TLI. The program did not suggest a modification index.

Chi-squared difference tests were performed to compare the models when adding direct paths from GSs to health/PA indicators, and these tests were not significant (full mediation versus GSs and PA indicators: $\Delta\chi 2$=11. 345; Δdf=6; p=.078; full mediation versus GSs and health indicators: $\Delta\chi 2$=9.642; Δdf=6; p=.141), meaning that adding the pathways did not significantly improve the model and that the pathways are redundant.

Figure 26. *Visualization of the proposed model of relationships between green space indicators, exposure to nature, physical activity and health*

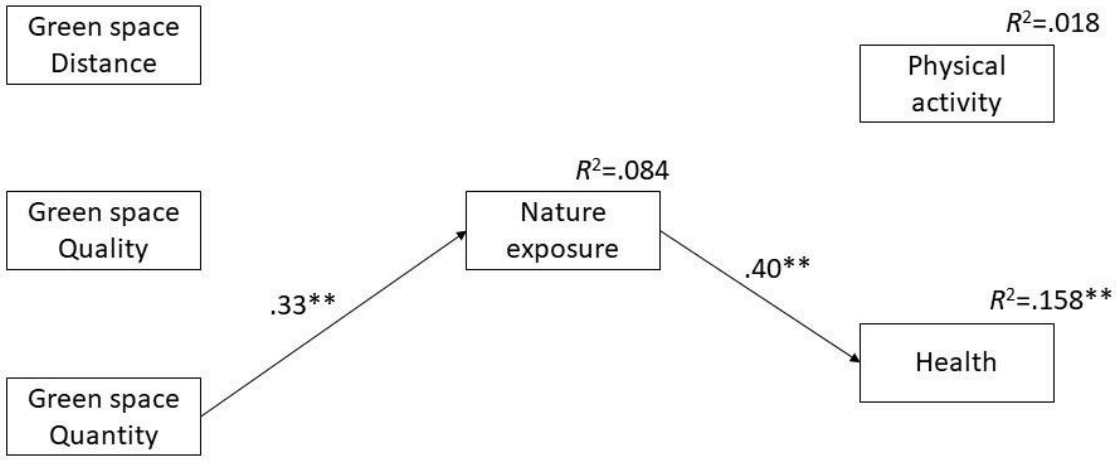


The resulting standardized parameter estimates are shown in Figure 27, where non-significant paths have been deleted to further emphasize the mediation paths tested in more depth. All of the mediations shown are significant at least at the 95% significance level, as can be seen from the bootstrapped confidence intervals excluding the zero value (when considering three decimal values) in Table 20.

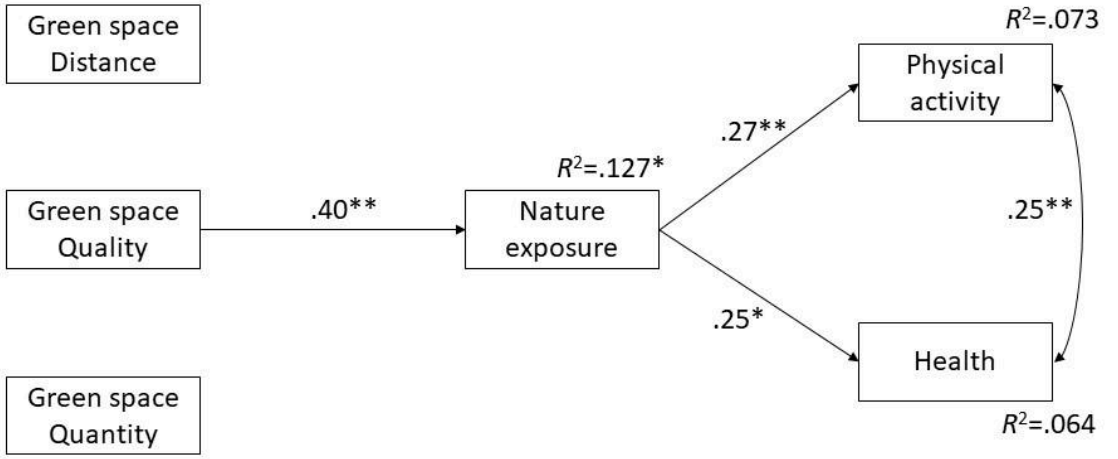
Figure 27

Benchmark route models (STDYX standardization)

- Spain -



- Croacia -



When considering the mediating role of CN between the indicators of GSs, PA and health, a bigger quantity of GSs predicted a higher level of health through a higher level of CN, based on the results obtained from students in Spain; at the same time, a higher quality of GSs predicted a higher level of health and PA through a higher CN among Croatian students (Table 20). Differences in the path coefficients between the two groups of students have also been tested by imposing equality restrictions for each path and checking whether this would reduce the model fit with chi-squared difference tests or not. The analyses showed that the only two significant differences were in the path coefficients between the quality of GSs and CN and the quantity of GSs and CN.

Similarly, the quantity of GSs predicted CN more for Spanish than for Croatian students ($\Delta\chi2$=5.108; Δdf=1; p=.023), while their quality predicted CN more for Croatian than for Spanish students ($\Delta\chi2$=9.385; Δ gl=6; p=.002). The other equality restrictions did not reduce the model fit (Evs, Distance, CN: $\Delta\chi2$=0.522; Δdf=1; p=.470; CN, AF: $\Delta\chi2$=1. 380; Δdf=1; p=.240; CN, health: $\Delta\chi2$=0.869; Δdf=1; p=.351; PA correlation with health: $\Delta\chi2$=2.405; Δdf=1; p=.121).

Table 20. Non-standardized estimates of indirect effects of international comparisons

Indirect effects	NSE of indirect effect	95% CI (k=1000)	99% CI (k=1000)
SPAIN **GSs Quantity → CN → Health**	1.780	0.451; 3.418	0.050; 4.094
CROATIA **GSs Quality → CN → PA**	0.071	0.021; 0.142	0.008; 0.165
CROATIA **GSs Quality → CN → Health**	1.584	0.322; 3.378	-0.024; 4.088

Note. NSE = Non-standardized estimates; CI = confidence interval; k = amount of simulations / *bootstrapped* samples

5.3. Discussion of the comparison

This study is the first attempt to examine the relationship between CN, health and PA among university students in a cross-national comparison. This study presents several interesting findings.

For example, the data obtained show a strong relationship between CN and PA practice in nature. This could be interpreted as an indication that the more time a student spends in nature, the more likely they are to engage in PA in nature, which has already been demonstrated along with its effects on personal well-being (Pasanen et al., 2014; Rosa et al., 2023).

Similarly, this contact with the natural environment is also related to the characteristics they present, especially when it comes to the number of GSs. It can be seen that there is a relationship between the variables obtained from university students in both countries, results that reflect similarities with other studies, such as that of Cox et al. (2017). This could indicate that if a student perceives a greater amount of green spaces, they are more likely to spend more time in them. Furthermore, the data also shows that quantity is a good predictor of CN to a greater extent for Spanish students, while quality is a good predictor for Croatian students. No research has been found comparing the characteristics of GSs in these

countries, but it has been found that the Croatian population is more likely to visit urban green spaces than the Spanish one (Ugolini et al., 2020).

It is also worth commenting on the possible influence of the different characteristics of the sample in each country. As most Spanish students practice sports as part of their studies, they are predisposed to do more PA in their everyday lives. PA in Spain is not correlated with health or CN, which can be explained by the nature of their usual lifestyle. Other studies provide us with data on PA levels in these countries; for example, in the 2020 European Health Survey in Spain (EHSS), 46.5% of men and 54.8% of women in Spain reported doing no physical activity in their free time. On the other hand, in Croatia, according to data collected in 2017 by the WHO in the European Health Questionnaire, 19.5% of the adult population is physically active: 22.7% of men and 17% of women reach the recommended PA levels.

In the samples studied, there are more male participants in Spain, whereas in Croatia most of the participants are women. Thus, the better health perception of Spanish students may be related to the fact that the respondents are male and more active than in Croatia, since it has already been observed that for women the quality of green spaces was more important (Brace et al., 2021) and do not have as much affinity for PA in nature (Rosa et al., 2023) as shown in this study. In addition, Croatian students mostly come from a smaller city near the sea and are relatively close to many natural areas, whereas most Spanish students live in larger cities with less availability of green spaces. It is also worth mentioning that this study found that a higher socio-economic status is associated with a bigger amount of green spaces near the place of residence, which was already reported by Klompmaker et al. (2023).

It is also worth noting that the analyses indicate that CN is related to health status in both countries. Particularly noteworthy are the Spanish data, where it is also observed that higher health status is also correlated with better GSs characteristics, which is also reflected in Geneshka et al. (2021); in the Croatian sample, it is observed that health is related to both PA levels and CN.

Furthermore, the data analyzed show a mediating role of CN. According to the Spanish data, it can be observed that a bigger quantity of GSs predicts a higher level of health through a higher level of CN, while according to the Croatian data, a higher quality of GSs predicts both a higher level of health and PA through a higher CN among the Croatian students. These results are in line with the findings of other studies such as Geneshka et al. (2021) or Nguyen et al. (2021). These reviews found significant relationships between health

and GSs exposure, with GSs quality being a predictor of health; however, they still reveal heterogeneity in the measurement of GSs exposure and GSs quality in research.

5.4. Limitations of the comparison

The biggest limitation of this investigation is the one it shares with the main study is the sample size. Since a considerable sample size was not reached, the researchers believe that this occurred given that the data collection time was short and also several students were reluctant to complete the questionnaire as it was in a second language (English) and not in own (Croatian); Hence lies the importance of having validated tools translated into as many languages as possible.

Chapter 6. EXPERIMENTAL STUDY

A summary of the research of Martínez & Šimunić (2023)[1] is provided, the purpose of which was to study the effects of short-term exposure to interactive versus non-interactive virtual nature on cognitive performance and mental health in university students. This study was approved by the ethics committee of the University of Zadar (2198-1-79-41/22-01), which can be seen in Annex 3.5.

6.1. Methodological Design

6.1.1. Research Design

The present research adopts an experimental design, specifically a randomized group design with pretest and posttest, unblinded by the researcher. This design allows to causally examine the impact of different conditions on the variables of interest, using measures both before and after the intervention.

Through a random sampling process, participants will be randomly assigned to three groups: interactive, non-interactive and control group. The sample will be selected considering the representativeness of the population. A series of pre-intervention tests were used to assess the variables of interest and then retested by the subjects at the end of the intervention, where the tests were performed right before and after the intervention.

The precise purpose of this research design is to evaluate the impact of different conditions on the variables of interest, using an experimental design with randomized groups and pretest and posttest measurements. Data analysis includes comparison of pretest and posttest results within each group, as well as comparison between groups. Analysis of variance (ANOVA) and mean comparison tests have been used to determine the statistical significance of the observed differences.

This study follows an experimental methodology, allowing the controlled manipulation of independent variables to evaluate their causal impact on the dependent variables. Objections may include the possibility that external factors may affect the results or that participation in an experimental group may influence the behavior of the participants. These objections have been addressed by careful study design and randomization of groups.

[1]This full study is available at:https://doi.org/10.1080/10447318.2023.2235122

The research was conducted in educational settings, during students' academic time. The study was conducted over a defined period of about 6 weeks, including sample selection, pretest application, intervention, posttest application and data analysis.

6.1.2. Participants

The sample was made up of 64 undergraduate students of psychology at the University of Zadar. There were 59 females and 5 males aged between 18 and 25 years with an average age of 20 years.

6.1.3. Instruments

Participants' age and gender were recorded, and a series of questions were developed to assess participants' general health and previous experience with VR; the full questionnaire can be found in Appendix 2. The VR headset used in this study was Meta Quest 2, a VR set consisting of a headset and two controllers with wireless internet connectivity.

For the non-interactive VR exposure, an immersive 360° VR video of different natural environments from the Youtube video *Virtual Nature 360°* - 5.7K Nature Meditation for Oculus Quest" was used[1].

The interactive nature VR experience used a special VR game called Nature Treks VR, which allows players to interact with wildlife and vegetation in different natural environments. The environment option called GREEN MEADOWS was selected in the application in this research.

The Simulator Sickness Questionnaire (SSQ; Kennedy et al., 1993) was also used. This is a questionnaire in which participants are asked to give subjective ratings of the severity of 16 symptoms on a scale from 0 (no perception) to 3 (marked perception) before and after the exposures.

The mental health assessment consisted of the Visual Analogue Mood Scale (VAMS), measured digitally using a demo version of the PsyToolkit software (Stoet, 2010; 2017).The VAMS assesses the level of mood states including happy, sad, calm, tense and energetic. During the assessment, the participants had to indicate where their mood was at that moment on the visual scale, with the far left part referring to a completely low level or absence of a mood, and the far right part referring to an extreme level of a mood. The scale score was converted to a numerical scale from 0 to 100. A paper-based Visual Analogue Scale (VAS)

[1] The video is available at the following link:
https://www.youtube.com/watch?v=7AkbUfZjS5k&ab_channel=ECOVR

ranging from 1 (not stressed at all) to 10 (extremely stressed) (Beverly et al., 2022) was used to measure the level of stress (Beverly et al., 2022).

Cognition was assessed using Trail Making (TMT) and Digit Span Test (DST). The TMT (Llinàs et al., 2017) is a widely used test, used to assess executive function in stroke patients. A number of mental skills, including letter and number recognition, mental flexibility, visual scanning and motor function, are required for successful performance on the TMT.

The test consists of 2 tasks: Part A and Part B. First, Part A consisted of 25 circles numbered 1 to 25 placed randomly on a sheet of paper or screen. The participant had to connect the circles with a pencil or finger as quickly as possible in a numerical order starting with 1. Part B then consisted of 25 circles marked with the numbers 1 to 13 and the letters A to L, randomly distributed on a sheet of paper or screen. A free mobile application specifically designed for use with the TMT (Léger & Mekari, 2022) was used in this study and the participant was asked to connect the circles with a pencil or finger as quickly as possible, alternating between numbers and letters and taking both sets in ascending order (i.e. 1, A, 2, B, 3, C, etc.). The time taken by the participant to complete the task correctly was recorded in seconds. Usually, a maximum time of 5 minutes is allowed for Part B.

The DST was used to measure the memory of the participants (Jones & Macken, 2015). This test was conducted in a demo version of the PsyToolkit software and consisted of remembering increasingly longer numerical sequences, starting with 2 and reaching a maximum of 9. The length of the sequence only increased after the participant had recalled the same length at least twice, making the DST measure more reliable. The test ended when two consecutive errors were made at the same level, or when the maximum score was reached.

6.1.4. Procedure

In the first place, participants' age and gender were recorded, and they were asked a series of questions to assess their general health (in particular regarding vision, balance, vertigo and mobility problems) and their previous experience in using VR on a scale from 1 (*No, I have never used it*) to 6 (*Yes, I have used it more than ten times*) (Browning et al., 2020). These questions can be found in Appendix 2. Eventually, all participants completed the Connectedness to Nature Scale (CNS) (Mayer & Frantz, 2004) in Psytoolkit.

As they were participating in the experiment, participants were asked to refrain from taking any drugs or substances that could alter their consciousness or mental state (alcohol, tobacco, caffeine, etc.) The sample was then randomly divided into 3 equal groups: virtual reality interactive nature (NVRI), virtual reality non-interactive nature (NVRNI) and a third control. Having completed this process, before the exposure to the medium itself, each participant underwent a cognitive assessment consisting of the TMT to measure their performance using a specific smartphone app, and the DST (Psytoolkit) to measure their memory (Léger & Mekari, 2022). Their current mental health was also assessed using the VAMS to assess mood (Machado et al., 2019), as well as a 1-10 VAS to assess perceived stress (Beverly et al., 2022). Finally, participants completed the Simulator Sickness Questionnaire (SSQ) (Bimberg et al., 2020).

Once this was done, the different groups were exposed to their respective environment. This exposure lasted 6 minutes per person (Browning et al., 2020) and participants were required to be relaxed and to keep as calm as possible. Subjects were seated in a swivel chair to facilitate observation of the 360° experience.

NVRI students were exposed to an immersive experience through a special VR game called Nature Treks VR, which allows players to interact with their own wildlife in different natural environments. NVRNI students were exposed to immersive 360° VR video in different natural environments.

Eventually, students in the control group spent these six minutes in VR staring at a blank white wall with no auditory stimulus (Figure 28). At the end of the exposure, the students underwent the same cognitive and mental health assessment again to compare results.

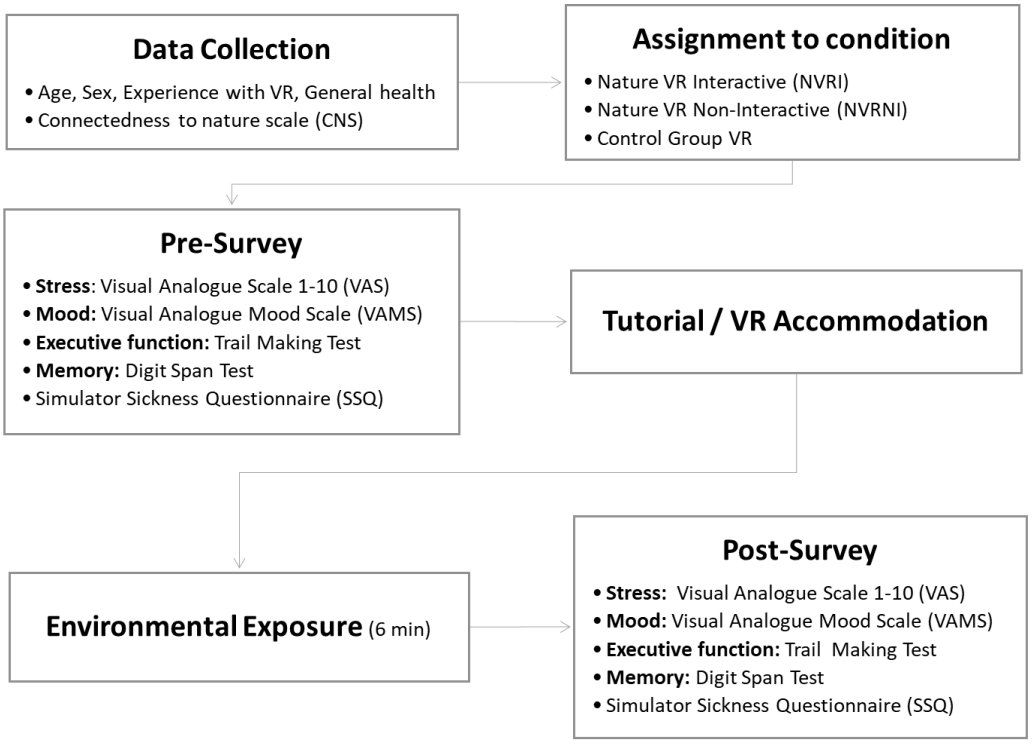
Figure 28.

Subject in the control group looking at a white wall in VR

In order to avoid favoring one cognitive test over another due to environmental exposure, the order of these tests was changed for each participant and the same order was noted in case it was necessary later to take the results obtained into account. Finally, in order to facilitate the understanding of the study, an outline of the different processes in the study is included below (Figure 29).

Figure 29.

Outline of the experimental VR study



6.1.5. Statistical analysis

The statistical analysis was performed using the Statistica™ 14 software. First, a descriptive analysis was performed to obtain means and standard deviations, and to analyze the indexes of distribution of the variables. Outliers (z-value lower than -3 or greater than +3) were then excluded from the final analysis to improve the consistency of the results.

Secondly, a two-way analysis of variance (3x2 mixed design) was performed to examine the differences in each variable measured before and after VR exposure in the different groups. Experimental group (type of VR exposure) and measurement period (before and after VR exposure) were used as the independent variables.

Lastly, with the calculated difference between the pre and post VR exposure measurement score (diff=post-pre) as the dependent variable, the CNS score as the covariate and the experimental group as the independent variable, an analysis of covariance was

conducted. Based on similar studies by Browning et al. (2020) and Liszio & Masuch (2019), the size of the sample has been calculated, using a 95% confidence level and a 5% margin of error, with an estimated size of no more than 20 participants per experimental group (formula: $n = Z^2 * (p) * (1-p) / E^2$). Our goal was at least 20 students per group.

6.2. Results

6.2.1. Descriptive parameters

First, regarding the questionnaire, the majority of participants did not show any negative aspects of health. Previous overall use of VR was low (1.5 out of 6), while connection to nature was higher (3.7 out of 5).

On the one hand, the main results show better data for the subjects in the VN group compared to the control group in terms of well-being (stress control=3.36 / happiness=55.80 vs. NVRNI stress=2.29 / happiness=70.33 vs. NRVI stress=2.14 / happiness=71.91). On the other hand, no significant differences were found between the VN groups. It was observed that the stress state improved in the interactive nature group (control stress=33.55 vs. NRVNI stress=23.48 vs. NRVI stress=13.87). Cognitive tests did not show any possible group effects in VN. The descriptive parameters of the research results in the whole sample and in the subgroups according to the condition in which the participants were found are shown in Table 21.

Table 21. Descriptive parameters of the pre- and post-exposure measurements

Group	Variable	N	M	SD	Range	S	K	N	M	SD	Range	S	K
	CNSscore	64	3,69	0,424	2,36 - 4,57	-0,29	0,87						
				Pre-Test						Post-Test			
	stress	64	3,61	1,981	1 - 8	0,64	- 0,56	62	2,53	1,762	1 - 8	1,22	0,86
	happy	64	61,91	16,179	8 - 100	-0,63	1,11	64	66,36	20,135	0 - 100	-0,69	1,13
All	*sad*	64	19,45	20,535	0 - 85	1,12	0,55	64	18,97	22,350	0 - 97	1,31	1,40
	calm	64	64,56	21,265	0 - 100	-0,48	-0,14	64	69,53	24,345	0 - 100	-0,70	0,29
	tense	64	33,83	22,960	0 - 85	0,10	-1,17	64	23,17	21,737	0 - 100	1,03	1,00
	energetic	64	49,80	21,231	0 - 100	0,04	0,01	64	52,92	20,461	0 - 95	-0,52	0,57
	SSQ	64	123,51	138,625	0 - 504,68	1,33	1,05	60	132,32	184,953	0 - 802,38	1,69	2,51
	tmta (sec.)	62	30,68	9,177	15 - 54	0,89	-0,02	63	26,46	6,483	16 - 47	1,04	1,37
	tmtb (sec.)	63	69,22	25,676	33 - 149	1,34	1,61	63	54,95	17,601	27 - 101	0,77	-0,08
	dst	64	6,41	1,080	4 - 9	-0,02	-0,37	64	6,44	1,194	3 - 9	0,07	0,33
	CNSscore	20	3,78	0,441	3,14 - 4,57	0,55	-0,95						
				Pre-Test						Post-Test			
	stress	20	3,6	2,087	1 - 8	0,41	-0,64	19	3,36	2,051	1 - 8	0,86	-0,08
	happy	20	59,95	16,969	8 - 84	-1,62	3,81	20	55,80	19,163	9 - 100	0,09	1,73
Control Group	*sad*	20	17,90	22,994	0 -85	1,81	2,76	20	28,65	27,889	0 - 97	0,98	0,38
	calm	20	59,35	23,629	0 -100	-0,64	0,69	20	57,40	23,585	3 - 100	0,25	0,87
	tense	20	37,55	25,560	0 -85	0,25	-1,12	20	33,55	25,832	0 - 100	0,65	0,73
	energetic	20	49,10	21,616	0 -86	-0,25	0,28	20	48,30	20,108	0 - 77	-0,34	0,12
	SSQ	20	150,60	155,733	0 - 485,38	1,03	0,11	18	169,15	179,687	0 - 513,73	0,68	-0,73
	tmta (sec.)	20	33,40	9,087	22 - 51	0,70	-0,69	20	27,00	8,182	16 - 47	1,21	1,32
	tmtb (sec.)	19	67,00	20,091	39 - 120	1,33	1,62	20	51,75	13,757	29 - 91	0,95	2,38
	dst	20	6,70	1,261	4 - 8	-0,59	-0,70	20	6,75	1,372	5 - 9	0,37	-1,02
	CNSscore	21	3,61	0,472	2,36 - 4,36	-1,08	1,51						
				Pre-Test						Post-Test			
	stress	21	3,14	1,957	1 - 8	1,24	0,84	21	2,29	1,736	1 - 7	1,54	1,92
	happy	21	61,43	18,824	27 - 100	0,05	-0,36	21	70,33	16,554	44 - 100	-0,12	-1,15
NVRNI	*sad*	21	22,67	21,666	0 - 71	0,60	-0,62	21	19,86	21,034	0 - 63	0,74	-1,00
	calm	21	66,33	20,068	30 - 98	-0,25	-0,91	21	72,33	23,733	16 - 100	-0,78	-0,06
	tense	21	29,90	20,176	0 - 63	0,19	-1,32	21	23,48	20,447	0 - 62	0,67	-0,76
	energetic	21	53,00	22,647	9 - 100	0,15	-0,32	21	57,52	21,981	3 - 95	-0,41	0,50
	SSQ	21	123,71	139,413	0 - 492,71	1,22	0,96	19	121,38	193,576	0 - 802,38	2,75	8,61
	tmta (sec.)	19	28,32	7,689	21 - 46	1,19	0,31	20	26,15	5,806	19 - 42	1,12	1,43
	tmtb (sec.)	21	74,00	35,605	33 - 149	1,06	-0,09	21	58,81	19,836	27 - 91	0,21	-1,28
	dst	21	6,29	0,902	4 - 8	-0,64	0,93	21	6,10	1,136	3 - 8	-0,66	1,65
	CNSscore	23	3,67	0,361	2,86 - 4,36	-0,07	0,44						
				Pre-Test						Post-Test			
	stress	23	4,04	1,894	1 - 8	0,42	-0,64	22	2,14	1,356	1 - 5	0,99	-0,16
	happy	23	64,04	13,051	37 - 84	-0,34	-0,87	23	71,91	21,119	0 - 100	-1,77	5,14
NVRI	*sad*	23	17,87	17,592	0 - 54	0,85	-0,64	23	9,74	13,471	0 - 39	1,32	0,35
	calm	23	67,48	20,250	31 - 96	-0,33	-1,24	23	77,52	22,287	0 - 100	-1,95	5,78
	tense	23	34,17	23,407	0 - 68	-0,30	-1,56	23	13,87	14,429	0 - 53	1,17	0,85
	energetic	23	47,48	20,127	0 - 91	0,10	0,71	23	52,74	19,255	0 - 87	-1,17	2,36
	SSQ	23	99,77	123,121	0 - 504,68	2,04	4,58	23	112,54	185,764	0 - 608,57	1,83	2,27
	tmta (sec.)	23	30,26	10,105	15 - 54	0,99	0,51	23	26,26	5,578	16 - 38	0,23	-0,52
	tmtb (sec.)	23	66,70	18,507	38 - 107	0,48	-0,40	22	54,18	18,531	29 - 101	1,15	0,87
	dst	23	6,26	1,054	5 - 9	0,70	0,55	23	6,48	1,039	4 - 8	-0,07	0,15

Note. S = Skewness; K = Kurtosis

Participants reported relatively more positive moods and lower levels of negative moods, including stress levels. On average, stress levels were at the lower end of the scale. The indexes of distribution shape (skewness and kurtosis) are within the acceptable range of

-/+3 for skewness and -/+10 for kurtosis, satisfying this way one of the requirements for parametric analysis.

6.2.2. Analysis of variance and covariance

Table 22 shows the results of two-way analyses of variance to examine differences in measurements before and after VR exposure in subjects exposed to nature non-interactively (NVRNI), interactively (NVRI) and to a white wall (control group). The SSQ values did not differ, demonstrating the absence of a modifying effect of the machine. Energy levels and daylight saving time values did not differ either.

Table 22. Results of two-way analysis of variance to examine differences in measurements before and after exposure

	F	**df**	**p**	**ηp 2**
VR Groups	0,970	2/61	0,385	0,031
Stress (before VR vs. after VR)	**45,776**	1/61	0,000	0,429
VR Groups x Stress (before VR vs. after VR)	**10,873**	2/61	0,000	0,263
VR Groups	2,191	2/61	0,121	0,067
Happiness (before VR vs. after VR)	**6,256**	1/61	0,015	0,093
VR Groups x Happiness (before VR vs. after VR)	**5,996**	2/61	0,004	0,164
VR Groups	1,396	2/61	0,255	0,044
Sadness (before VR vs. after VR)	0,001	1/61	0,972	0,000
VR Groups x Sadness (before VR vs. after VR)	**9,819**	2/61	0,000	0,244
VR Groups	**3,210**	2/61	0,047	0,095
Calmness (before VR vs. after VR)	2,558	1/61	0,115	0,040
VR Groups x Calmness (before VR vs. after VR)	1,428	2/61	0,248	0,045
VR Groups	1,854	2/61	0,165	0,057
Tenseness (before VR vs. after VR)	**25,250**	1/61	0,000	0,293
VR Groups x Tenseness (before VR vs. after VR)	**6,417**	2/61	0,003	0,174
VR Groups	0,727	2/61	0,488	0,023
Energy (before VR vs. after VR)	1,478	1/61	0,229	0,024
VR Groups x Energy (before VR vs. after VR)	0,587	2/61	0,559	0,019
VR Groups	1,032	2/57	0,363	0,035
SSQ (before VR vs. after VR)	0,441	1/57	0,509	0,008
VR Groups x SSQ (before VR vs. after VR)	0,009	2/57	0,991	0,000
VR Groups	1,413	2/58	0,252	0,046
tmta (before VR vs. after VR)	**15,290**	1/58	0,000	0,209
VR Groups x tmta (before VR vs. after VR)	1,124	2/58	0,332	0,037

VR Groups	0,022	2/56	0,978	0,001
tmtb (before VR vs. after VR)	**24,757**	1/56	0,000	0,307
VR Groups x tmtb (before VR vs. after VR)	1,345	2/56	0,269	0,046
VR Groups	1,738	2/61	0,184	0,054
dst (before VR vs. after VR)	0,026	1/61	0,874	0,000
VR Groups x dst (before VR vs. after VR)	0,560	2/61	0,574	0,018

Note.*p< .05, **p< .01, ηp 2 = partial eta squared

When considering stress, happiness and tenseness, a significant main effect at the time of the assessment and a significant interaction effect with the participant group were observed. The Bonferroni post hoc tests showed that stress was lower after CN of VR for both interactive and non-interactive groups, except for the control group.

The effect was more pronounced in the interactive group than in the non-interactive one. As for happiness levels, the Bonferroni post hoc tests showed no significant results, so Fisher's least significant difference test (LSD) was performed to find out the nature of the interaction. This showed that, with the exception of the control group, levels of happiness were significantly higher in both groups after exposure to nature. It was also shown that the estimated level of happiness after the exposure was higher in the groups that were exposed to nature than in the control group. When looking at tenseness, the Bonferroni post hoc tests showed that the estimated level of tenseness was lower after and not before VR exposure only in the group exposed interactively to nature.

The interaction between the groups exposed to different conditions and the time of the test was significant for the data related to sadness. Interestingly, the Bonferroni post hoc tests showed that pre- and post-exposure sadness did not differ in the two nature-exposed groups, but increased in the control group. Regarding calmness, it was only the main effect of the groups (VR exposure condition) that played an important role, but the Bonferroni post hoc tests showed no significant effect, except for a nearly significant difference (p=.057), which reflected higher levels of calmness after the exposure itself in the group exposed interactively to nature compared to the control group.

For the TMT, parts A and B, the main effect of the test time was significant. On average, scores were better after exposure than before. However, according to the Bonferroni post hoc tests, this is only significant for the control group for part A and for the control and non-interactive exposure groups for part B.

In the context of a two-way analysis of variance to assess differences in measurements before and after exposure to VR groups, partial eta squared (ηp^2) coefficients were employed

to examine the contribution of factors and their interactions to the variance in several emotional and cognitive variables. For instance, in the variable "Stress," the "VR Groups" factor explained 3.1% of the variance, while the interaction between "VR Groups" and "Stress" was more influential, explaining 42.9%. Similarly, in "Happiness," the "VR Groups" factor contributed 6.7%, and the interaction with "Happiness" explained 9.3% of the variance.

In "Sadness," the "VR Groups" factor explained 4.4%, and the interaction did not contribute to the variance. Additionally, "Tenseness" showed that the "VR Groups" factor explained 5.7%, and the interaction explained 29.3%. In "Energy" the "VR Groups" contributed 2.3%, and the interaction with "Energy" explained 2.4%. The "SSQ" variable revealed that "VR Groups" explained 3.5%, and the interaction explained 0.8%. Regarding "tmta," "VR Groups" contributed 4.6%, and the interaction explained 3.7%. "Tmtb" indicated that "VR Groups" explained 0.1%, while the interaction explained 30.7%. Finally, in "dst," "VR Groups" contributed 5.4%, and the interaction explained 1.8%.

Table 23 reflects the results of two-way analyses of covariance to examine differences in the change in scores before and after VR exposure (post-exposure scores were not counted in the pre-exposure scores) for those exposed to nature non-interactively (NVRNI), interactively (NVRI) and to a white wall (control group). The covariate in these analyses was connectedness to nature.

Table 23. Results of two-way analysis of covariance to examine the differences in changes in outcomes before and after exposure

Dependent variable	Source of variability	F	df	p	ηp 2
Stress (pre VR - post VR)	*Connection with nature*	0,321	1/59	0,573	0,005
	VR Groups	**9,995**	2/59	0,000	0,253
Happiness (pre VR - post VR)	*Connection with nature*	0,580	1/60	0,449	0,010
	VR Groups	**5,401**	2/60	0,007	0,153
Sadness (pre VR - post VR)	*Connection with nature*	1,461	1/60	0,232	0,024
	VR Groups	**10,444**	2/60	0,000	0,258
Calmness (pre VR - post VR)	*Connection with nature*	0,002	1/60	0,965	0,000
	VR Groups	1,391	2/60	0,257	0,044
Tenseness (pre VR - post VR)	*Connection with nature*	0,005	1/60	0,945	0,000
	VR Groups	**6,308**	2/60	0,003	0,174
Energy (pre VR - post VR)	*Connection with nature*	0,427	1/60	0,516	0,007
	VR Groups	0,677	2/60	0,512	0,022
tmta	*Connection with nature*	0,001	1/57	0,982	0,000

(pre VR - post VR)	*VR Groups*	1,070	2/57	0,350	0,036
tmtb	*Connection with nature*	0,130	1/55	0,719	0,002
(pre VR - post VR)	*VR Groups*	1,256	2/55	0,293	0,044
dst	*Connection with nature*	0,396	1/60	0,532	0,007
(pre VR - post VR)	*VR Groups*	0,513	2/60	0,601	0,017

Note. *p< .05, **p< .01, ηp 2 = partial eta squared

The results show no difference in the magnitude of change in pre- and post-exposure scores between the different groups (VR conditions) for calmness, tenseness, energy, TMT part A and B, and DST. There are group differences for stress, happiness, sadness and tenseness, which is consistent with the interaction effects mentioned above (Table 23).

From the results of partial eta square it can be determined for Stress the "VR Groups" factor related to connection with nature explained 25.3% of the variance. In the case of "Happiness," the contribution was 15.3%, and for "Sadness," it was 25.8%. Additionally, the "VR Groups" factor contributed 4.4% to the variance in "Calmness," 17.4% to "Tenseness," and 2.2% to "Energy."

In the cognitive domain, the "VR Groups" factor explained 3.6% of the variance in "tmta" and 4.4% in "tmtb", while for "dst", it contributed 1.7%. These results offer insights into the varying impacts of "VR Groups" concerning connection with nature on emotional and cognitive responses, highlighting its relative importance across different dependent variables.

Bonferroni post hoc tests were carried out. The group exposed to interactive nature perceived a more pronounced change or decrease in stress and tenseness levels than the control group and the group exposed to non-interactive nature. The control group perceived a decreased level of happiness and an increased level of sadness compared to the two groups exposed to nature, where happiness increased and sadness decreased.

6.3. Discussion

Currently, how the interaction between humans and this environment replicates the benefits of exposure to real nature is one of the fundamental limitations in our understanding of VN. This study extends the findings of previous research on VN and its effects on mood (Riches et al., 2021) by adding further evidence about the benefits exposure to VN has on health. However, in contrast to other research (Mostajeran et al., 2021), it has been found to

have a neutral effect on cognitive performance. In this sense, it has been observed a relationship between connection with nature and the benefits that can be derived from the exposure to it, which has already been reflected in other research such as in Leung et al. (2022).

After analyzing the data, evidence shows that interacting with nature has potential benefits in terms of stress and different moods (stress, happiness and tenseness); particular benefits were observed in terms of happiness when exposed to a natural environment and also at the level of tenseness when comparing an interactive natural environment with a non-interactive one, having the former a better effect.

Previous research has shown that videos of nature in VR also have beneficial effects (White et al., 2018). This happens to be the first study that compares this type of video with a fully VR environment, which has been shown to be inferior in terms of benefits (Hedblom et al., 2019). In this case, the virtual environment was made interactive to overcome the limitations mentioned above, while also aiming to account for a range of individual differences related to nature, health and cognitive performance.

Following the same line, the data show no significant increases in cognitive tests in the three groups, except for different parts of the TMT. There could be several reasons behind this, for example, the subjects could have improved their scores simply by repeating the same tests shortly before the immersive experience, whereas the control group could have remembered the test they had just done to a greater extent, as they did not have this interaction and shift of attention with the VN, i.e. they had no other stimuli during the intervention period.

In addition, as mentioned above, the SSQ scores are similar between the groups, so there was no change in the results due to the use of VR. In terms of general health questions, practically all subjects showed the same positive results, except for a few. The same was true for the VR experience, with the vast majority reporting little or no previous exposure to this technology. It is also important to note that, based on the results, there may be preference for more relaxing activities like NVRNI and also for more energetic ones like NRVI, depending on the lifestyle of the participants and other related factors (Carballo-Fazanes et al., 2020), which is probably why the results do not show much difference between the two nature groups. Positive effects may not change much after a simulated nature experience due to various factors, such as boredom or disengagement while watching environmental videos, as these states conflict with positive affect (Brooks et al., 2017).

One factor that has not been discussed is that in the NVRNI group, in addition to the natural environmental noises, the video itself had a slight accompaniment of music, but this is not considered to be a crucial factor, although future research might want to consider this. This happens because, as this is an additional stimulus, it could influence the interaction with the proposed environment in a pleasurable way (Eisenberger et al., 2010).

The results spotlight the distinct influence of interactive virtual nature, revealing a more profound effect on emotional well-being. Participants exposed to interactive virtual nature reported a significant reduction in stress levels compared to their counterparts in both non-interactive and control groups. The emotional responses to virtual nature were intricate, illustrating a dynamic interplay between exposure conditions and individual differences in nature connection.

Both groups exposed to virtual nature displayed heightened levels of happiness and diminished levels of sadness compared to the control group. Particularly noteworthy was the finding that individuals with a stronger connection to nature experienced more pronounced stress reduction when exposed interactively. This underscores the intricate role of individual differences in shaping emotional responses to virtual nature environments.

While cognitive performance was assessed through tasks like the TMT and DST, discernible group effects were not observed. This outcome suggests that the primary benefits of virtual nature interventions may be rooted in emotional well-being, with immediate cognitive enhancements playing a secondary role.

In-depth exploration using partial eta squared coefficients highlighted the pivotal role of nature connection in moderating the relationship between virtual nature exposure and emotional and cognitive variables. This underscores the importance of tailoring interventions based on an individual's connection to nature, recognizing the diversity in responses within the study cohort.

6.4. Limitations

Limitations of the study itself include the small sample size, which, although not small, is not as statistically powerful as in other studies (Léger & Mekari, 2022; Browning et al., 2020). For this reason, physiological measurement instruments such as heart rate variability (Blum et al., 2019), electrodermal activity (Browning et al., 2020), and salivary cortisol (Annerstedt et al., 2013) have not been used for objective evaluation of stress levels and relaxed states.

Chapter 7. CONCLUSIONS

7.1. Conclusions of the Observational Studies

This research highlights the complexity of the interactions between environment, PA, health and academia. Factors such as age, gender, disability, level of education, participation in exchange programs and modality of study were found to be interrelated and to play a key role in people's perceptions and behaviors in relation to their environment.

Ultimately, these findings highlight the need for multidisciplinary approaches that integrate education, health, environment and sport to promote general well-being and greater respect for the natural environment in contemporary society. Further research is needed to determine the extent and relative impact of NBIs, and to quantify the combined effect of the factors that increase connectedness to GSs. This needs to be accompanied by a general improvement in study design to support the effectiveness of these NBIs in improving the health of individuals. Therefore, a better understanding of the elements that promote greater connectedness to natural outdoor environments, such as increased biodiversity, a sense of being in a natural space, accessibility, as well as opportunities for PA and pollution reduction, will probably contribute to improved health and reduced health inequalities (Nejade et al., 2022).

Analyzing the objective of the dissertation if CN favors the state of health (SF-12) in university students it has been proven that the findings robustly support the overarching hypothesis that a higher level of CN is positively associated with better health status among university students. This alignment underscores the potential role of nature connectedness as a contributing factor to overall well-being. Regarding the objective of whether the NC favors the PA, the study confirms that a heightened sense of CN correlates with increased PA levels among students. This suggests that fostering a deeper connection to nature may be a key element in promoting a more active lifestyle.

Responding to another of the research objectives, the investigation establishes a significant relationship between PA levels and health status among university students. Higher levels of PA correspond to better overall health, reinforcing the well-established link between an active lifestyle and improved well-being. Regarding the objective of the relationship between the main variables, the intricate relationships among GS characteristics, CN, PA levels, and health outcomes come to light. Notably, the quality and quantity of GS,

alongside CN, influence the amount of PA performed in nature. This nuanced understanding emphasizes the role of accessible and quality GS in shaping both nature connectedness and PA behaviors.

Concerning the aims related to the secondary variables, the exploration of secondary variables reveals subtle differences among university students. Gender, age, socio-economic status, and academic pursuits contribute to the complexity of these relationships, highlighting the need for tailored interventions that consider the unique characteristics of diverse student populations. In reference to the objectives concerning the characteristics of the GS, the study illuminates the significance of the quantity, distance, and quality of GS in the area of residence. Proximity to well-maintained GSs is associated with higher levels of CN, increased physical activity, and better health outcomes, emphasizing the role of urban planning in shaping health-promoting environments.

The conclusions drawn from this comprehensive investigation have practical implications for public health interventions, urban planning, and health promotion strategies targeting university students. As society moves forward, further research endeavors could explore longitudinal dynamics, experimental interventions, and cross-cultural comparisons to deepen our understanding of these complex relationships and inform evidence-based strategies for promoting the well-being of university students.

Thus, by testing the proposed hypotheses, this research sheds light on the complex interaction between environment, PA and health, and explains how different personal and academic factors influence this dynamic. It also shows that understanding the complex interaction between environment, PA, health and the academic component is essential to promote a holistic approach to wellbeing and sustainability in our young society.

7.2. Conclusions of the Experimental Study

The findings partially support the idea of Conditioned Restoration Theory (Egner et al., 2020), which essentially suggests that nature itself does not have anti-stress effects, but acts through conditioning mechanisms after associating nature with relaxation. Although it does not explain why all groups had an improvement by feeling calmer, there is evidence that nature, in this case virtual nature, has a reinforcing effect as well as being a conditioning factor (Browning et al., 2023).

As the results show, in relation to the objectives of interaction with nature, subjects with a greater connection to nature, and therefore a greater association of well-being with it,

obtain a greater enhancement of its effects at the level of mental well-being, as can be seen in Oh et al. (2021). This would be closer to the concept of the biophilia hypothesis, which suggests that humans' innate connection to nature is essential for their well-being, and that contact with the natural environment provides direct benefits in the form of reduced stress levels and cognitive enhancement in the form of increased creativity (Yin et al., 2019).

This study offers a nuanced understanding of the impact of virtual nature experiences on the emotional well-being of university students, drawing conclusions from an exploration of both interactive and non-interactive virtual nature effects. From the objective of analyzing the effects of interactive and non-interactive virtual nature on the stress level of university students, the results reveal a significant reduction in stress levels among participants exposed to interactive virtual nature, emphasizing the potential therapeutic benefits of actively engaging with virtual natural environments. This effect was notably more pronounced in the interactive group, highlighting the importance of interactive elements in fostering stress reduction.

Regarding the objective of the thesis on the state of mind, both groups exposed to virtual nature reported elevated levels of happiness and reduced sadness compared to the control group. Nature connection emerged as a crucial factor influencing emotional responses, particularly in stress reduction and mood enhancement. Tailoring virtual nature interventions based on individuals' nature connections could optimize the therapeutic impact of these experiences.

Concerning the objectives on academic capability, interestingly, cognitive performance, as assessed through tasks like the Trail Making Test and Digit Span Test, did not show significant group effects. Nature connection played a pivotal role in shaping individual responses to virtual nature, acting as a modifying factor in stress reduction, mood enhancement, and overall emotional well-being. This underscores the importance of considering individual differences in nature connection when designing interventions involving virtual nature.

Practically, the findings have implications for incorporating virtual nature experiences into stress management and mood enhancement interventions for university students. Crafting interactive virtual nature experiences aligned with participants' nature connections could be a promising strategy for promoting emotional resilience and well-being.

Finally, it should be added that this study is one of the few that has compared the effects of an interactive natural environment with a non-interactive one, with results similar to others of the same type (Liszio & Masuch, 2019; Szczepańska-Gieracha et al., 2021). The

data from this research encourages further exploration of the restorative effects of nature in its virtual form on mental health and mood, and makes VN a useful tool for improving the well-being of university students.

Chapter 8. PROSPECTS

8.1. Prospects of the Observational Studies

This research shows the contribution of CN to university students' lifestyles and how the characteristics of GSs can be of great importance to their well-being. It is evident that systematic reviews on these topics have examined a wide range of outcomes. However, the influence of the natural environment on the development of favorable long-term mental and physical health outcomes is still uncertain due to the lack of consistent guidelines for studying the effects of the natural environment on health (Britton et al., 2020; Trøstrup et al., 2019). Therefore, it is suggested that further research should objectively analyze the characteristics of GSs in each area, at least quantitatively, so as not to rely solely on subjective assessments. In addition, this type of research could be complemented with the reasons for people's contact with nature, in order to understand the reasons they have for interacting with these types of spaces and the types of activities they carry out in them, in order to provide more specific and credible explanations of the associations between the study variables.

Future research should take a more holistic approach to the issue, for example by conceptualizing GSs beyond quantity, quality or distance. This could help to understand causal pathways and improve the design of interventions (Geneshka et al., 2021). For this reason, further research on these topics should be carried out and it is suggested to obtain more relevant and specific information from each sample studied to further highlight the role nature plays in our everyday lives (Nigg et al., 2023). Also, looking at the results, it would be interesting to look more closely at the issue of disability, by facilitating accessibility and connection to these urban environments in order to provide greater inclusion of this population (Zhang et al., 2017).

Regarding the translation and validation of the NES-II, the ECN, the functionality of having instruments validated in languages besides English has already been seen, as it expands the boundaries of evidence in the research field. For this reason, the author suggests the translation of more instruments into multiple languages to expand this horizon, such as the

Connectedness to Nature Scale (Pasca et al., 2017). Also, focusing on this scale in particular, it would be interesting to create a second version of it and add a few more items focusing on health and GSs. It would also be interesting to add more research using other validated instruments, such as the WHOQOL-BREF (Høegmark et al., 2022), the PANAS (Próchniak, 2022) or the Nature Relatedness Scale (McSweeney, 2021), among others, as this will provide more reliable data on which to base future evidence of nature's potential in this area.

On the other hand, in terms of international comparison, it would be suggestive to carry out similar research with more countries, just in the same way as it has been done on a small scale, and to be able to analyze the impact of this set of variables on the socio-cultural aspects of each area. At the level of sustainability, it would be necessary to analyze how to improve access to GSs and their characteristics, and to see what public impact this would have, especially at the level of health (Mygind et al., 2021). Also, in this type of research, it would be useful to look at the population in more detail, especially by their area of residence (amount of GSs per inhabitant / community comparison / etc.) to better understand the data. In addition, future longitudinal and experimental research is suggested to test the mediation model proposed in this study.

In conclusion, research opportunities in this area appear to be very promising and worthy of further attention. As modern society continues to evolve in terms of lifestyles and academic commitments, it is important to better understand how CN could enhance PA and health benefits in this population. The human-nature connection has the potential to provide novel solutions to physical and mental health problems in academia. However, an interdisciplinary and longitudinal approach is needed to properly work out the underlying mechanisms and provide effective suggestions.

8.2. Prospects of the Experimental Study

The above experiment is just a small glimpse of what VR has to offer. With a growing body of research investigating the effects of VR technology on our connection with nature, as well as the increasing popularity and affordability of VR devices among the general public, VR now has more and more applications in our society (Brambilla et al., 2022).

The problem of nature deficit (Louv, 2008), as well as premature deaths that could be avoided by having better access to nature (Barboza et al., 2021), have been raised in the context of increasing urbanization, which is likely to result in reduced opportunities to interact with nature and other challenges to people's health. VN has therefore been proposed

as a possible solution to integrate more frequent nature experiences into people's everyday lives, and even to encourage people to actively seek out more opportunities to interact with nature.

However, research and applications of VN in the context of health promotion, particularly in relation to nature connectedness outcomes, are still at an early stage (Frost et al., 2022). In this sense, further studies of VR and VN based on university populations are also lacking (Browning et al., 2023; Lau et al., 2023; Sneed et al., 2021).

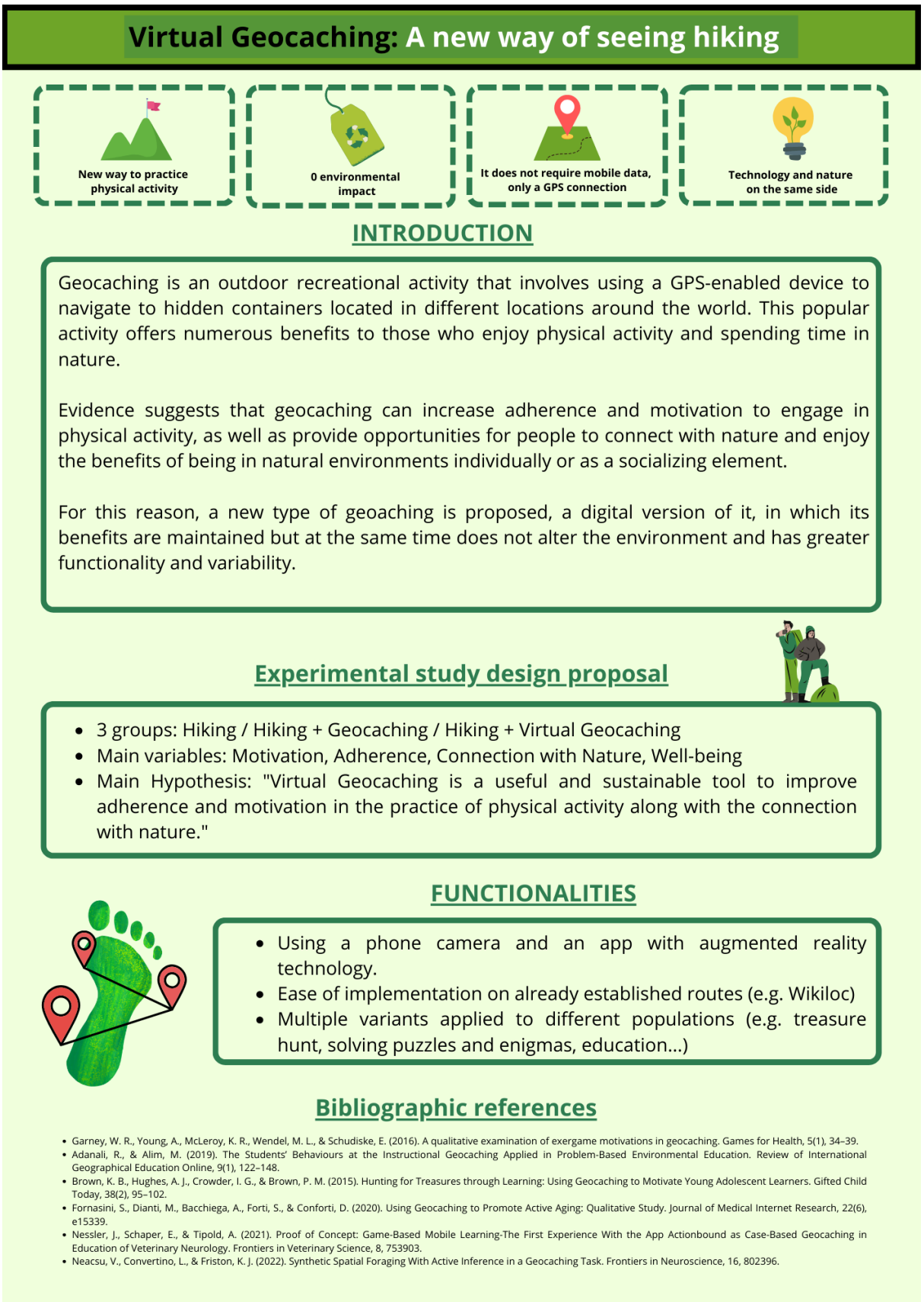
Finally, it must not be forgot that there are other technologies that bring people closer to VN, such as Augmented Reality (Rodríguez-Abad et al., 2022), the Metaverse (Kye et al., 2021; Petrigna & Musumeci, 2022) or Artificial Intelligence (Nishant et al., 2020; Richie, 2022). These must be seen as tools and guides that bring us closer to a greater understanding and affinity in the human-nature relationship, in order to create new resources to help society reinforce this interaction.

Considering the short-term nature of the study, future research could explore the long-term effects of virtual nature exposure and expand participant demographics, incorporating a more comprehensive set of cognitive measures. As technology continues to integrate into daily life, understanding the nuanced effects of virtual nature becomes increasingly significant for mental health and overall well-being. In conclusion, this research adds valuable insights into the therapeutic potential of virtual nature experiences, indicating a promising avenue for leveraging technology to enhance emotional well-being among university students.

Thus, the author concludes this study with his own proposal (among the many others that can be offered), which includes the union of many of the concepts presented in this research: CN, health, PA, connection with nature, education, VN and GSs. This proposal suggests virtual geocaching as a way to improve motivation and compliance with PA and CN in university students, combining both environments: natural and virtual, through a system of sustainability and respect for the environment (Figure 30).

Figure 30

Proposal for a study on virtual geocaching



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ANNEXES

ANNEX 1. Research Questionnaire (Observational Study)

Section 1

Dear Student,

We inform you of this questionnaire that is part of the study/thesis "The influence of contact with nature on the practice of physical activity and the state of health" carried out by the Catholic University of Valencia.

The main objective is to analyze the relationship between the contact with nature, physical activity and health in university students.

(The duration of this questionnaire is approximately 5 minutes)

It is totally ANONYMOUS.

- Project code: UCV/2021-2022/118
- Type of study: Doctoral Thesis

Section 2

Participant Information Sheet (HIP)

INTRODUCTION

We are writing to inform you about a research study in which you are invited to participate. The project has a favorable report from a Research Ethics Committee of the Institution promoting the study.

Our intention is that you receive correct and sufficient information so that you can evaluate and judge whether or not you want to participate in this study. To do this, read this information sheet carefully and we will clarify any doubts that may arise. In addition, you can consult with the people you consider appropriate.

VOLUNTARY PARTICIPATION

You should know that your participation is free and voluntary; you can decide not to participate. If you decide to participate, you can change your decision and withdraw consent at any time without your decision causing you any harm.

THE PURPOSE OF THE STUDY

The purpose of the study is to analyze whether NC promotes health and physical activity in university students. At the same time, it has a more ecological awareness and sustainability approach that seeks to promote green spaces and stays in nature.

STUDY PROCEDURES

It will be done through several questionnaires to be filled out autonomously; one on basic personal data (age, sex, institution, area of residence and a series of questions about green spaces in the area of residence) and then a series of questionnaires (3 in total) on health, physical activity and contact would be completed with nature.

RISKS AND DISCOMFORT ARISING FROM YOUR PARTICIPATION IN THE STUDY

The study does not foresee any discomfort or risk when carrying it out. Study participants are responsible for completing the questionnaires.

Participation in the project will not entail any cost; The only foreseeable expense is the travel itself to the area where the intervention will be carried out, according to the assigned group.

POTENTIAL BENEFITS

No direct benefit is expected from your participation in the study.

RIGHT TO REVOKE CONSENT

If you change your mind regarding your participation in the study and the transfer of the data provided, you have the right to revoke it through the principal investigator of the study. However, you should know that the data obtained up to that point may be used for the purposes requested and may be kept in compliance with the corresponding legal obligations.

ECONOMIC COMPENSATION

The participant will not receive any financial benefit from his or her participation in this study. By accepting informed consent, the participant waives any right of an economic nature to the results or potential benefits that may be derived, directly or indirectly, from the research.

PERSONAL DATA PROTECTION

The promoter and the center undertake to comply with Regulation (EU) 2016/679 of April 27 regarding the protection of natural persons in relation to the processing of their personal data (hereinafter the "Regulation") and the Spanish regulations on application (Organic Law 3/2018, of December 5, on the Protection of Personal Data and guarantee of digital rights).

The data collected for the study will be identified by a code, so that no information that could directly identify you is not included. Access to your identified personal information will be restricted to the study doctor/collaborators, health authorities, the Research Ethics Committee and personnel authorized by the promoter, when needed to verify the data, study procedures, and compliance with regulations. of good clinical practice; but always maintaining their confidentiality. Your identity may be revealed in exceptional cases, such as medical emergencies for your health or legal requirements. The processing, communication and transfer of personal data of all participants will comply with the provisions of the applicable regulations.

All the information we request from you is necessary to be able to participate in this trial and is mandatory to provide in order to guarantee the correct development of the trial. The data collected for the study will last at least up to 25 years in the custody of the researcher after its completion. Subsequently, his personal information will only be maintained by the Center for his health care.

In accordance with current regulations, you have rights over your personal data. However, we inform you that there are some limitations in order to guarantee the validity of the research and comply with legal duties.

To exercise your rights, contact the principal investigator of the study or the Data Protection Officer of the center [dpd@ucv.es]. Likewise, we inform you of your right to file a claim with the Data Protection Agency regarding any action by the Promoter or the Center that you consider violates your rights.

Your coded data may be transmitted to third parties and other countries, always for the same purposes of the study described or for use in scientific publications and always maintaining their confidentiality in accordance with current legislation (in no case will they contain information that can identify you). directly, such as first and last name, initials, address, social security number, etc.).

Both the Center and the main researcher are respectively responsible for the processing of your data and undertake to comply with data protection regulations.

Participant's right to be informed or not, about the results:

The participant who requests it will have the right to be informed about the results of the research.

Right of access, rectification, deletion, portability and opposition:

The participant is responsible for the veracity and correctness of the data provided. and you have the power to exercise the rights of access, rectification, deletion, limitation of processing, portability and opposition of your data in accordance with the provisions of the data protection regulations and the manner of doing so.

To exercise them, you must write to the person responsible for the research requesting the exercise of the right. The participant will attach a copy of his or her DNI or equivalent document, in order to guarantee his or her identity.

CONTACT IN CASE OF DOUBTS

If during your participation you have any questions or need more information, please contact Fran Martínez Manchón (Principal Investigator) via email (fmarman@mail.ucv.es) or telephone (652244567).

Informed consent

(Participant of legal age - 16 years or older - or emancipated minors)

I declare that I have received from Fran Martínez Manchón clear information and to my full satisfaction about the study entitled "The influence of contact with nature on the practice of physical activity and the state of health" with Code UCV/2021-2022/118 and whose Principal Investigator belonging to the Catholic University of Valencia San Vicente Mártir is Fran Martínez Manchón in which I voluntarily want to participate.

I declare that:

- I have read the Participant Information Sheet about the cited study.
- I have been given a copy of the Participant Information Sheet (HIP) and a copy of this signed Informed Consent.
- I have had the time and opportunity to ask questions and raise any doubts I had.
- All questions were answered to my satisfaction.
- I agree that the team can contact me again later to continue with this study, if they need it.
- I have been assured that the confidentiality of my data will be maintained.

- I give consent voluntarily and I know that I am free to withdraw from the study at any time during the study, for any reason and without any negative effect on me.

For all this, I give my consent:

1- For my participation in the proposed study.

2- For the storage of my personal data in the place and conditions indicated in the HIP.

3- To allow the use of my personal data for future research related to this study.

Section 3

Ad Hoc Questionnaire

Sex: (Male/Female)

Age:

Institution (University):

Do you currently reside in Spain?: (Yes / No)

Place of residence (name of city/town,...):

Nationality:

Indicate your socioeconomic level: (High / Medium / Low)

Do you currently work?:

Do you have any disability? If so, tell us its %:

- I do not have any disability.
- Class 1. Disability 0%.
- Class 2. Disability from 1 to 24%.
- Class 3. Disability from 25 to 49%.
- Class 4. Disability from 50 to 70%.
- Class 5. Disability equal to or greater than 75%.

Are you currently federated and practicing any sport?: (Yes / No)

What level of studies are you currently pursuing?

- Degree
- Master
- Doctorate
- Other

What type of study are you pursuing? (medicine, architecture,...):

Are you in ERASMUS, exchange program or similar?: (Yes / No)

What type of study modality are you taking?: (In-person / Online)

Natural environments

These "natural environments" can be in urban areas (urban parks, for example) or rural areas. They may include elements such as plants and animals (native or not), natural geography (e.g. hills, mountains, deserts, beaches, swamps), natural waterways and aquatic landscapes (e.g. rivers, streams, lakes, ponds and seas). Having a vision that includes these types of natural environments is also relevant. This contrasts with the so-called "built environment" of houses, buildings, roads and all other man-made structures.

How far is the nearest green space (urban or natural environment) from your usual area of residence?

- <300m
- 300m to 1km
- 1km to 5km
- >5km

Rate the general quality of green spaces in your usual area of residence

5	**4**	**3**	**2**	**1**
High				Null

Rate the general amount of green space in your usual area of residence

5	**4**	**3**	**2**	**1**
High				Null

Section 4

Nature Exposure Scale (NES-II)

We are interested in your exposure to nature, both in your everyday life and activities, and when you take yourself on excursions outside of your everyday environments. We are also interested in your use of natural environments for physical activity. Please complete the following questions to reflect your current level of exposure to natural environments and participation in physical activity within these environments.

These ‘natural environments’ could be in urban (city parks for example) or rural areas. They could include things such as plants and animals (native or non-native), natural geography

(e.g., hills, mountains, deserts, beaches, marshlands), natural water courses and waterscapes (e.g., rivers, streams, lakes, ponds and ocean). Having a view which includes these types of natural environments is also relevant. This is in contrast to the so-called 'built environment' of houses, buildings, roads and all other such structures created by humans.

Nature Exposure in Your Everyday Life and Environments

Item 1: In your everyday home, travel and work environments and activities, please rate your level of exposure to natural environments (please circle a number)

5	**4**	**3**	**2**	**1**
High		Medium		Low
Most of my everyday environment is natural		About half of my everyday environment is natural		Very little of my everyday environment is natural

Item 2: How much do you notice the natural environments in your everyday life (please circle a number)?

5	**4**	**3**	**2**	**1**
A great deal		Somewhat		Not much

Nature Exposure during Excursions OUTSIDE of Everyday Life Environments

These questions relate to your level of exposure to nature when you are outside your everyday environments. This would include trips you make in your leisure time (or occasionally as part of your study, work or social activities) to nature-rich environments in urban, rural or wilderness areas. These might be places that you travel to once a week, or less frequently, either for the express purpose of being in the natural environment or for some other main purpose.

Item 3: Please rate the frequency (how often) of exposure to nature-rich environments outside your everyday environment (please circle a number)

5	**4**	**3**	**2**	**1**
High		Medium		Low
Once a month or less		Once every 6 months		Once a year or less

Item 4: How much notice would you take of the nature in these environments (please circle a number)?

5	**4**	**3**	**2**	**1**
A great deal		Somewhat		Not much

Nature Exposure during Physical Activity

These questions relate to your level of exposure to nature when you are engaging in physical activity. Physical activity in natural environment (called Green Exercise) might include activities such as walking, gardening, fishing, jogging or cycling. These physical activities could be conducted as part of, or coincidental to an everyday activity, or be a planned period of exercise. They might take place in urban, rural or wilderness areas.

Item 5: Please rate the frequency (how often) in which you perform physical activity in nature-rich environments (please circle a number)

5	**4**	**3**	**2**	**1**
High		Medium		Low
Weekly		Once every 6 months		Once a year or less

Item 6: How much notice would you take of the nature when you are performing physical activity (please circle a number)?

5	**4**	**3**	**2**	**1**
A great deal		Somewhat		Not much

Section 5

Health survey (SF-12)

Instructions

The questions that follow are about what you think about your health.

Your answers will let us know how you are doing and to what extent you are able to do your usual activities. Please answer each question by checking a box. If you are not sure how to answer a question, please answer what you think is most true.

1. In general, would you say your health is:

- Excellent
- Very good
- Good

- Fair
- Poor

The following two questions are about activities you might do during a typical day. Does YOUR HEALTH NOW LIMIT YOU in these activities? If so, how much?

2. MODERATE ACTIVITIES, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf:

- Yes, Limited A Lot
- Yes, Limited A Little
- No, Not Limited At All

3. Climbing SEVERAL flights of stairs:

- Yes, Limited A Lot
- Yes, Limited A Little
- No, Not Limited At All

During the PAST 4 WEEKS have you had any of the following problems with your work or other regular activities AS A RESULT OF YOUR PHYSICAL HEALTH?

4. ACCOMPLISHED LESS than you would like:

- Yes
- No

5. Were limited in the KIND of work or other activities:

- Yes
- No

During the PAST 4 WEEKS, were you limited in the kind of work you do or other regular activities AS A RESULT OF ANY EMOTIONAL PROBLEMS (such as feeling depressed or anxious)?

6. ACCOMPLISHED LESS than you would like:

- Yes
- No

7. Didn't do work or other activities as CAREFULLY as usual:

- Yes
- No

8. During the PAST 4 WEEKS, how much did PAIN interfere with your normal work (including both work outside the home and housework)?

- Not At All
- A Little Bit
- Moderately
- Quite A Bit
- Extremely

The next three questions are about how you feel and how things have been DURING THE PAST 4 WEEKS. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the PAST 4 WEEKS

9. Have you felt calm and peaceful?

- All of the Time
- Most of the Time
- A Good Bit of the Time
- Some of the Time
- A Little of the Time
- None of the Time

10. Did you have a lot of energy?

- All of the Time
- Most of the Time
- A Good Bit of the Time
- Some of the Time
- A Little of the Time
- None of the Time

11. Have you felt downhearted and blue?

- All of the Time
- Most of the Time
- A Good Bit of the Time

- Some of the Time
- A Little of the Time
- None of the Time

12. During the PAST 4 WEEKS, how much of the time has your PHYSICAL HEALTH OR EMOTIONAL PROBLEMS interfered with your social activities (like visiting with friends, relatives, etc.)?

- All of the Time
- Most of the Time
- A Good Bit of the Time
- Some of the Time
- A Little of the Time
- None of the Time

Section 6

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for atleast 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

2. How much time did you usually spend doing vigorous physical activities on one of those days? (example: if you spend 20 minutes write 20 / reply in minutes)

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

4. How much time did you usually spend doing moderate physical activities on one of those days? (example: if you spend 20 minutes write 20 / reply in minutes)

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

6. How much time did you usually spend walking on one of those days? (example: if you spend 20 minutes write 20 / reply in minutes)

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day? (example: if you spend three hours and a half write 3.5 / reply in hours)

ANNEX 2. Research Questionnaire (Experimental Study)

Student Code: _____
Age: _____
Sex: _____

Connected Nature Scale Score (Link): _____

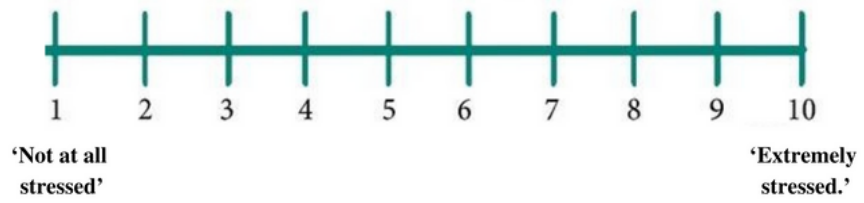
- Do you think your general health is good?
  - ☐ Yes
  - ☐ No
- Have you been diagnosed with a mental illness or mood disorder and/or are you taking any medication for it?
  - ☐ Yes
  - ☐ No
- Do you have any health problems about your balance?
  - ☐ Yes
  - ☐ No
- Do you have any health problems with your vision?
  - ☐ Yes
  - ☐ No
- Do you wear glasses?
  - ☐ Yes
  - ☐ No
- Do you have any health problems related to vertigo?
  - ☐ Yes
  - ☐ No
- Do you have any health problems regarding mobility (especially neck and upper extremities)?
  - ☐ Yes
  - ☐ No

Rate your virtual reality experience (1 to 6):
(1- "No, never used it" / 6- Yes, more than ten times I have used it)
_____

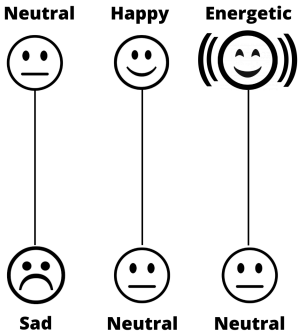
The participant must not be under the influence of any drug or substance that may alter his/her consciousness or mental state (alcohol, tobacco, caffeine,...) when performing the experiment.

Student Code: _____
Group: NVRI / NVRNI / RV

Pre-TEST



Stress: _____



VAMS (Link): _____

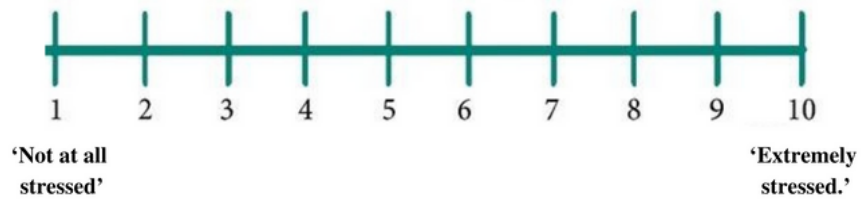
General discomfort	None	Slight	Moderate	Severe
Fatigue	None	Slight	Moderate	Severe
Headache	None	Slight	Moderate	Severe
Eye strain	None	Slight	Moderate	Severe
Difficulty focusing	None	Slight	Moderate	Severe
Increased salivation	None	Slight	Moderate	Severe
Sweating	None	Slight	Moderate	Severe
Nausea	None	Slight	Moderate	Severe
Difficulty concentrating	None	Slight	Moderate	Severe
"Fullness of the head"	None	Slight	Moderate	Severe
Blurred vision	None	Slight	Moderate	Severe
Dizzy (eyes open)	None	Slight	Moderate	Severe
Dizzy (eyes closed)	None	Slight	Moderate	Severe
Vertigo (Giddiness)	None	Slight	Moderate	Severe
Stomach awareness	None	Slight	Moderate	Severe
Burping	None	Slight	Moderate	Severe

SSQ: _____

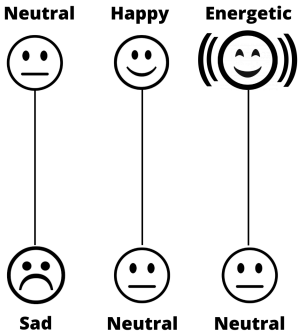
TMT-A: _____
TMT-B: _____
DST: _____

Student Code: _____
Group: NVRI / NVRNI / RV

Post-TEST



Stress: _____



VAMS (Link): _____

General discomfort	None	Slight	Moderate	Severe
Fatigue	None	Slight	Moderate	Severe
Headache	None	Slight	Moderate	Severe
Eye strain	None	Slight	Moderate	Severe
Difficulty focusing	None	Slight	Moderate	Severe
Increased salivation	None	Slight	Moderate	Severe
Sweating	None	Slight	Moderate	Severe
Nausea	None	Slight	Moderate	Severe
Difficulty concentrating	None	Slight	Moderate	Severe
"Fullness of the head"	None	Slight	Moderate	Severe
Blurred vision	None	Slight	Moderate	Severe
Dizzy (eyes open)	None	Slight	Moderate	Severe
Dizzy (eyes closed)	None	Slight	Moderate	Severe
Vertigo (Giddiness)	None	Slight	Moderate	Severe
Stomach awareness	None	Slight	Moderate	Severe
Burping	None	Slight	Moderate	Severe

SSQ: _____

TMT-A: _____
TMT-B: _____
DST: _____

ANNEX 3. Research ethics committees

3.1. Certificate from the UCV ethics committee on the project's Research Plan

Universidad Católica de Valencia San Vicente Mártir

INFORME DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE LA UNIVERSIDAD CATOLICA DE VALENCIA SAN VICENTE MÁRTIR (CEI).

Dra. Mar Aranda Jurado, Secretaria del Comité de Ética de la Investigación de la Universidad Católica de Valencia San Vicente Mártir

Certifico que:

Ha tenido entrada en la reunión del Comité de Ética de la Investigación (CEI) de la Universidad Católica de Valencia San Vicente Mártir en su reunión, de fecha **10 de marzo de 2022**, la solicitud de evaluación del proyecto de investigación, relacionado a continuación:

Título: **"La influencia de la exposición a la naturaleza en la práctica de actividad física y el estado de salud de los estudiantes universitarios".**

Código del proyecto: **UCV/2021-2022/118**

Investigador Principal: **Francisco de Asís Martínez Manchón**

El Comité de Ética de la Investigación ha acordado **informar favorablemente el mismo**.

Valencia, 25 de marzo de 2022.

MARIA MAR| ARANDA| JURADO

Firmado digitalmente por MARIA MAR|ARANDA|JURADO
Nombre de reconocimiento (DN): cn=MARIA MAR|ARANDA|JURADO, serialNumber=52648490H, givenName=MARIA MAR, sn=ARANDA JURADO, ou=CIUDADANOS, o=ACCV, c=ES
Fecha: 2022.03.25 14:48:56 +01'00'

Mar Aranda Jurado
Secretaria del Comité de Ética de la Investigación

3.2. Certificate from the UCV ethics committee on the translation and validation study of the NES-II

Universidad Católica de Valencia San Vicente Mártir

INFORME DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE LA UNIVERSIDAD CATOLICA DE VALENCIA SAN VICENTE MÁRTIR (CEI).

Dra. Mar Aranda Jurado, Secretaria del Comité de Ética de la Investigación de la Universidad Católica de Valencia San Vicente Mártir

Certifico que:

Ha tenido entrada en la reunión del Comité de Ética de la Investigación (CEI) de la Universidad Católica de Valencia San Vicente Mártir en su reunión, de fecha **19 de mayo de 2022**, la solicitud de modificación en el proyecto de investigación, relacionado a continuación:

Título: "**La influencia de la exposición a la naturaleza en la práctica de actividad física y el estado de salud de los estudiantes universitarios".**

Código del proyecto: **UCV/2021-2022/118**

Investigador Principal: **Francisco de Asís Martínez Manchón**

El Comité de Ética de la Investigación ha acordado aceptar la modificación solicitada:

- El instrumento seleccionado "Nature Exposure Scale II" no está traducido al español ni validado en población española, por lo que se solicita poder incluir esta traducción y validación.

Valencia, 24 de mayo de 2022.

MARIA MAR| ARANDA| JURADO

Firmado digitalmente por MARIA MAR|ARANDA|JURADO
Nombre de reconocimiento (DN): cn=MARIA MAR|ARANDA|JURADO, serialNumber=52648490H, givenName=MARIA MAR, sn=ARANDA JURADO, ou=CIUDADANOS, o=ACCV, c=ES
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Mar Aranda Jurado
Secretaria del Comité de Ética de la Investigación

3.3. Certificate from the ethics committee of the UCV on the comparative study between Croatian and Spanish students

Universidad Católica de Valencia San Vicente Mártir

INFORME DEL COMITÉ DE ÉTICA DE LA INVESTIGACIÓN DE LA UNIVERSIDAD CATOLICA DE VALENCIA SAN VICENTE MÁRTIR (CEI).

Dra. Mar Aranda Jurado, Secretaria del Comité de Ética de la Investigación de la Universidad Católica de Valencia San Vicente Mártir

Certifico que:

Ha tenido entrada en la reunión del Comité de Ética de la Investigación (CEI) de la Universidad Católica de Valencia San Vicente Mártir en su reunión, de fecha **31 de octubre de 2023**, la solicitud de modificación en el proyecto de investigación, relacionado a continuación:

Título: **"La influencia del contacto con la naturaleza en la práctica de actividad física y el estado de salud de los estudiantes universitarios".**

Código del proyecto: **UCV/2021-2022/118**

Investigador Principal: **: Francisco de Asís Martínez Manchón**

El Comité de Ética de la Investigación ha acordado aceptar la modificación solicitad: : Realizar un estudio comparativo a partir de los datos obtenidos de las muestras de estudiantes españoles y croatas con los mismos objetivos principales de la tesis.

Valencia, 30 de noviembre de 2023

MARIA MAR| ARANDA| JURADO

Firmado digitalmente por MARIA MAR|ARANDA|JURADO
Nombre de reconocimiento (DN): cn=MARIA MAR|ARANDA|JURADO, serialNumber=52648490H, givenName=MARIA MAR, sn=ARANDA JURADO, ou=CIUDADANOS, o=ACCV, c=ES
Fecha: 2023.11.30 12:25:47 +01'00'

Mar Aranda Jurado
Secretaria del Comité de Ética de la Investigación

3.4. Certificate from the ethics committee of the University of Zadar on the observational study on Croatian students

Sveučilište u Zadru
Universitas Studiorum
Jadertina | 1396 | 2002 |

ETIČKO POVJERENSTVO

KLASA: 114-06/22-01/33
URBROJ: 16-22-02
Zadar, 8. rujan 2022.

Doc. dr. sc. Ana Šimunić

Predmet: Suglasnost za provedbu znanstvenog istraživanja – doc. dr. sc. Ana Šimunić - daje se

Na temelju zamolbe KLASA: 114-06/22-01/33, URBROJ: 16-22-01 od 12. srpnja 2022. godine Etičko povjerenstvo Sveučilišta u Zadru održalo je VII. redovitu sjednicu. Etičko povjerenstvo jednoglasno je odobrilo zamolbu doc. dr. sc. Ana **Šimunić** za provedbu istraživanja pod naslovom „Contribution of Exposure to Nature to Physical Activity Practices and the Health Status of Croatian University students". Podatci će se prikupiti putem upitnika.

Etičko povjerenstvo napominje da je pri provedbi istraživanja potrebno pridržavati se Etičkog kodeksa Sveučilišta u Zadru, smjernice struke unutar koje je obavlja istraživanje, te postupati u skladu s odredbama Opće uredbe o zaštiti osobnih podataka (GDPR) i Zakona o provedbi Opće uredbe o zaštiti podataka.

Predsjednica Etičkog Povjerenstva

doc. dr. sc. Danijela Birt Katić

Etičko povjerenstvo, Ulica Mihovila Pavlinovića 1, 23000 Zadar, Hrvatska
t: 023 200 665., f: 023 316 882
OIB: 10839679016, e-mail: info@unizd.hr, www.unizd.hr

3.5. Certificate from the ethics committee of the University of Zadar on the study of Virtual Reality

University of Zadar
Universitas Studiorum
Jadertina | 1396 | 2002 |

KLASA: 602-04/22-01/15
URBROJ: 2198-1-79-41/22-01
Zadar, 21 st October 2022

Department of Psychology
Šimunić Ana Ph.D.
Assistant professor

Ethics committee of Department of Psychology –
decision on research proposal

Respected Dr. Šimunić Ana,

We hereby inform you that Ethics committee of Department of Psychology has looked into your research proposal ***Effects of short-term exposure to interactive vs non-interactive virtual nature on cognitive performance and mental health in college students*** and that the same is approved.

Jelena Ambla, Assistant professor
Ethics committee of Department of Psychology

...

University of Zadar, Department of Psychology, Ob.kralja Petra Krešimira IV/2, 23000 Zadar, Croatia
t: 0038523200535 ., f:
OIB: , e-mail: jlevac@unizd.hr