**Title**: Práctica de actividad física, sensibilidad estacional y bienestar psicológico de personas que viven en climas extremos.

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## Abstract

**Objective**: […]. **Material and methods**: […]. **Results**: […]. **Conclusion**: […].

**Keywords**: […].

# Introduction

The benefits of incorporating regular exercise, as well as maintaining a high level of physical activity as part of daily living activities, have been extensively studied and are well known. Some of these are summarised as improved cardiorespiratory fitness, reduced risk of cardiometabolic diseases, improved self-esteem and mood, promotion of social integration, improved management of chronic diseases and many other multiple associated benefits that translate into a better quality of life at different stages of life ([1](#ref-Bull2020),[2](#ref-alvarez-pitti2020)). On the other hand, it has been well studied that sedentary behaviours increase the risk of cardiovascular diseases, diabetes, obesity, stroke, among others ([3](#ref-Lavie2019),[4](#ref-mosquera2021sedentarismo)).

According to the World Health Organisation (WHO), a person is considered physically active when he or she engages in moderate-intensity aerobic physical activity for at least 150-300 minutes; or intense aerobic physical activity for 75-150 minutes; or an equivalent combination of both moderate and intense activities throughout the week. Muscle-strengthening activities performed on two or more days in a week that involve all major muscle groups are also considered ([5](#ref-who2020physical)).

Physical exercise can be performed both outdoors and indoors, however, there is emerging evidence suggesting that outdoor exercise promotes a decrease in perceived stress, mediated by the action of the parasympathetic nervous system, as well as increases in vitamin D levels, even showing a decrease in the risk of myopia, when compared to the same activity performed indoors ([6](#ref-Manferdelli2019)–[8](#ref-Wang2021)). However, outdoor exercise may be hindered by fluctuating climatic conditions across the world. In high southern latitude areas, cold weather prevails for most of the year and, at the same time, there are cyclical changes of natural light in relation to the seasons of the year, thus conditioning the life of the inhabitants of the region ([9](#ref-rivas2018clima)).

Seasonal changes in natural light that affect high southern latitude areas can condition the mood of the people living there, leading to what is known as “seasonal sensitivity” (SE). This concept is related to the time of exposure to sunlight, which increases during the summer months and decreases considerably during the winter months. This disorder is characterised by hypersomnia, increased appetite for carbohydrates, weight gain and extreme fatigue ([10](#ref-alvarado-aravena2021),[11](#ref-gueichatureoasencio2021)). From a physiological point of view, these changes can lead to disruptions in the circadian cycle, hormonal dysregulation, such as melatonin, which is directly related to sleep disturbances, and a decrease in neurotransmitters, such as serotonin, which is related to the depressive symptoms associated with SE ([12](#ref-lewy1988)–[14](#ref-wirz2018seasonality)). The autonomic nervous system is also affected, which can lead to autonomic dysregulation, variations in vagal tone and alterations in cardiac regulation in the face of stress, which can lead to an increased risk of cardiovascular disease ([15](#ref-austen2001increased),[16](#ref-ardell2011neurocardiology)). On the other hand, mental health is also affected by alterations in natural light, where higher levels of anxious and depressive symptoms can occur, which can lead to a psychopathological phenomenon called Seasonal Affective Disorder (SAD), generating consequences in the social adaptation and perception of happiness of the individual, directly related to a lower quality of life of the person who suffers from it ([10](#ref-alvarado-aravena2021),[17](#ref-munir2022seasonal)–[19](#ref-fonte2021seasonal)).

In Chile, 81.3% of the population engages in some kind of physical activity and/or sport ([20](#ref-ministerio2020cuenta)). The Region of Magallanes and Chilean Antarctica is located in the extreme south of the country, which is classified as high southern latitude, and is therefore characterised by a cold climate and seasonal changes in natural light. In this area, only 36.2% engage in physical activity or sport, which may or may not be directly influenced by geographical conditions and the seasonal cycle of light ([21](#ref-ministerio2017politica)). On the other hand, the relationship between physical exercise, SE and well-being of people living in high southern latitude has not been studied in Latin America, which is why the main objective of this study is to determine whether there are relationships between the practice of physical exercise, SE and well-being in people living in high southern latitude, so that, based on this, sports programmes can be designed based on the reality of these regions and thus promote physical activity and sport, favouring the health of the inhabitants with absolute relevance in their development.

# Material y methods

## Study design

This study is a non-experimental correlational study with two consecutive stages. First […]; and the second […].

## Participants

The participants in this study were selected by non-random, accidental sampling from the city of Punta Arenas, Chile, located at latitude 53º south. High latitude south is defined as latitude 50º to the South Pole. In total, 358 people participated in this study. Inclusion criteria included being of legal age, residing in the city of Punta Arenas for at least 6 months of the year, not having any degree of disability, being able to read and answer the questionnaire, and whether or not they were involved in any type of physical activity or sport, according to WHO parameters. Similarly, participants were excluded if they: had any physical or psychological disability associated with the application of the questionnaires, did not comply with the rules for filling out the form, were pregnant, and had incomplete answers to any of the questionnaires.

## Measures

### Seasonal pattern assessment questionnaire (SPAQ)

The Seasonal Profile Assessment Questionnaire (SPAQ) was applied, which is a self-administered and timeless scale composed of 6 items measuring seasonal variation in mood during the months of the year ([22](#ref-adan2006propiedades),[23](#ref-goikolea2003adaptacion)). This test produces an overall Seasonal Score Index (SSI), indicating the presence of Seasonal Affective Disorder (SAD), which reflects a depressive picture with a seasonal pattern (SP); Winter Blues, which is a milder form of SAD, a sub-syndrome (SAD-S) ([24](#ref-melrose2015seasonal)). Another item assesses the degree of severity, determining whether seasonal changes are considered a problem.

### Psychological well-being scale

This scale addresses different sub-scales: Self-acceptance, a person’s ability to feel good about themselves; Positive relationships, a person’s perception of establishing stable social relationships and having friends they can trust; Autonomy, a person’s ability to resist social pressure to a greater extent and to self-regulate their behaviour; Environmental mastery, personal ability to choose or create favourable environments to meet one’s needs; Personal growth, striving to develop one’s potential and maximise one’s capabilities; Purpose in life, which refers to a person’s ability to define a set of goals that enable him or her to give his or her life some meaning. Each of these instruments is easy to apply and in total there are 4 sheets that were answered in a Likert-type format, for the convenience and speed of the participant.

## Procedures

Participants voluntarily signed an informed consent form and then completed the detailed instruments in a single session. These were self-administered during the winter, as the assessment of symptom presence is more direct at this time (average daylight hours winter: 2.8; summer: 7.4). Each assessment was scheduled in a free time of 1 hour min to answer all questions.

### Collection of demographic data

Participant’s gender, age, city of origin, length of stay in the region and presence of psychological illnesses were recorded through anamnesis. Length of stay in the ALS region was surveyed for each participant.

### Physical activity

The report of sport engagement was obtained through the application of a survey of selection questions and the classification of sports subjects was based on the WHO recommendations, which state that at least 150 minutes per week of moderate physical activity, or at least 75 minutes per week of vigorous physical activity, or an equivalent combination of moderate and vigorous physical activity, should be practised. In an ideal practice, they should reach 300 minutes of moderate physical activity per week, or its equivalent. Muscle-strengthening activities should be considered 2 or more days per week and in such a way that large muscle groups are exercised.

## Statistical analysis

The data is presented as median (*Mdn*) and interquartile range (*IQR*) for continuous variables; for categorical/discrete variables, the absolute and relative sample size was reported.

A non-parametric approach was used since the underlying distribution of measured outcomes, assessed through analytical and graphical methods, did not follow a Gaussian distribution. The *Wilcoxon* () and *Kruskal-Wallis* () rank-sum tests were used for between-subjects analyses, meanwhile the chi-square test () was used to evaluate goodness-of-fit () and independence of factors (). In order to assess the association between numeric variables, *Spearman’s* rho statistic () was calculated. Effect sizes and their respective 95% confidence intervals were also estimated for each statistic.

A probability of committing a type I () error of less than 5% (*p* < 0.05) was considered sufficient evidence for statistical significance in hypothesis testing. All the statistical analyses were computed and implemented in the R programming language ([25](#ref-rlanguage)).

# Results

Three hundred and fifty-eight subjects were part of the final sample, of which a significantly higher proportion of males (56%) than females (44%) ( (1) = 5.67, *p* = 0.017). The age variable was considered as a two-level categorical variable, and could be grouped into subjects aged 18 to 35 years or older than 35 years. The proportion of subjects aged 18 to 35 years was significantly higher than those aged 35 years and older ( (1) = 4.93, *p* = 0.026).

We found that 194 persons (54.2%) reported doing sport. We observed that with increasing levels of self-reporting of sport intensity, there was a significant decrease in the proportion of people with SAD (Figure 2).

The SSI had a proportional effect on the summer pattern variable. Subjects classified within the SAD group scored higher on this pattern than those in the Winter blues and Normal groups ( (2)= 20.76, *p* < 0.001, = 0.06, CI95%[0.03, 1.00]). A similar trend was observed for SSI on the winter pattern, where the SAD group recorded higher scores on the winter pattern than those in the Winter blues and Normal group ( (2) = 52.28, *p* < 0.001, = 0.15, CI95%[0.09, 1.00]); those with a mixed-type pattern had a higher proportion of people with SAD compared to those with a winter pattern (Figure 2). In relation to self-reported severity of seasonal sensitivity, it was observed to have a positive effect on SSI (Figure 3). Furthermore, a positive correlation between winter and summer pattern was observed ( = 0.48, CI95%[0.40, 0.56], *p* < 0.001). On the other hand, when looking at the relationship between seasonal sensitivity and participants’ well-being, a negative correlation was found between winter pattern and the subcategory of autonomy ( = -0.11, CI95%[-0.21, 0.00], *p* = 0.044).

In terms of gender, male subjects have a higher score in environmental control than females ( = 18106.5, *p* = 0.01, = 0.15, CI95%[0.04, 0.27]) and in turn a higher score on the purpose in life domain ( = 18084.5, *p* = 0.01, = 0.15, CI95%[0.03, 0.27]). A negative effect was found between SSI and five subcategories of the RYFF Well-Being Scale, namely self-acceptance, autonomy, environmental mastery, personal growth and purpose in life (Figure 1).

# Discussion

The main objective of this study was to determine the relationship between the practice of physical exercise, SE and well-being of people living in high southern latitude. According to our results, 54.9% of our study population performs some type of physical activity and/or sport, which is higher compared to the 2017 records ([21](#ref-ministerio2017politica)); this may be due to the fact that in these 5 years the population that performs physical activity has increased.

In our study population 76% have some degree of SE and, of this percentage, 87% consider seasonality to be a problem for them. In the case of the study by Alvarado-Aravena et al, almost half of the subjects did not perceive SE as a problem ([10](#ref-alvarado-aravena2021)). This difference could be due to the fact that nowadays people are more informed about the fact that the characteristics of the environment in which they develop can influence their health, as is the case of the seasonality of natural light at high southern latitudes. Based on this, a direct relationship was found between SE and the perceived severity classification of SE (Figure 2), where the higher the perceived severity, the higher the proportion of people with SE.

On the other hand, of the percentage who reported physical activity, 84% exercised at medium to high intensity. This is important to bear in mind, as there is an inverse relationship between SE and the intensity of physical activity, so it can be considered that the more intense the exercise, the lower the probability of SE (Figure 2).

Regarding the perception of psychological well-being, an inverse relationship was found between SE and multiple domains of the Ryff Scale: self-acceptance, autonomy, environmental control, personal growth and life purposes, so that, globally, in the presence of SE there is less psychological well-being, which may lead to a decrease in the performance of physical activity and/or sport, increasing the likelihood of suffering from some degree of SE.

# Conclusion

[…]

# Data availability statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author/s.

# Ethics Statement

The studies involving human participants were reviewed and approved by The Ethics Committee of the University of Magallanes, Chile (Nº141CEC2018). The patients/participants provided their written informed consent to participate in this study.

# Author Contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

# Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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![](data:application/pdf;base64,) **Figure 1**. Differences between different SSI levels on Ryff’s parameters of psychological well-being.

![](data:application/pdf;base64,) **Figure 2**. Proportion between different levels of SSI and the severity of self-perceived seasonality.