

# Performance at the Santiago 2023 Pan American Games: Prediction using a simple exponential smoothing method.

## Rendimiento en los Juegos Panamericanos de Santiago 2023: Predicción mediante método de suavización exponencial simple

### Desempenho nos Jogos Pan-Americanos de Santiago 2023: Predição usando o método de suavização exponencial simples

Jorge Flández<sup>1</sup>, Rodrigo Vargas<sup>2</sup>, Víctor Jacques<sup>3</sup>, Miguel Cornejo<sup>4</sup>, Rubén Gajardo-Burgos<sup>5</sup>, Frano Giakoni-Ramírez<sup>6</sup>, José Aguilar<sup>7</sup>, Raúl Urbina<sup>8</sup> & Daniel Duclos-Bastías<sup>9</sup>

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#### ABSTRACT

The objective of this paper is to analyze the sports performance of the Chilean delegation in the Pan American Games held between 1951 and 2023, using retrospective and projective data through time series. For this purpose, a quantitative, non-experimental and longitudinal design of trends and a simple exponential smoothing method was used, which uses historical averages and allows a prediction or future behavior based on a weighted average of current and past values. From the results obtained, it was possible to conclude that, in recent decades, Chile's position in the Pan American Games ranking has stabilized around eleventh place, a position predicted for Santiago 2023. Maintaining similar conditions, the general and specific sporting performance would not have an exponential break in the trend and the results are not favorable, specifically in terms of obtaining gold medals and the overall position of the delegation.

**Key words:** Pan American Games; Sports performance; Elite sport; Forecasting technique; Simple exponential smoothing.

<sup>1</sup> Doctor en Ciencias de la Actividad Física y el Deporte. Instituto Ciencias de la Educación, Universidad Austral de Chile, Chile. <https://orcid.org/0000-0002-4088-7449> | [jorge.flandez@uach.cl](mailto:jorge.flandez@uach.cl)

<sup>2</sup> Doctor en Ciencias de la Educación. Departamento de Ciencias de la Actividad Física, Facultad de Educación, Universidad Católica del Maule, Talca, Chile. <https://orcid.org/0000-0002-7554-9589> | [rvargas@ucm.cl](mailto:rvargas@ucm.cl)

<sup>3</sup> Magíster en Economía. Docente MBA, Universidad Austral de Chile, Chile. <https://orcid.org/0000-0002-7528-8374> | [victorjacq@gmail.com](mailto:victorjacq@gmail.com)

<sup>4</sup> Dr. Sciences et Techniques des Activités Physiques et Sportives. Profesor Titular Educación Física. Facultad de Educación, Universidad de Concepción, Chile. <https://orcid.org/0000-0003-4579-605X> | [mcornejo@udec.cl](mailto:mcornejo@udec.cl)

<sup>5</sup> Magíster en Rehabilitación Deportiva. Instituto de Aparato Locomotor y Rehabilitación, Universidad Austral de Chile, Chile. <https://orcid.org/0000-0002-4515-2492> | [ruben.gajardo@uach.cl](mailto:ruben.gajardo@uach.cl)

<sup>6</sup> Doctor en Ciencias del Deporte. Facultad de Educación y Ciencias Sociales, Instituto del Deporte y Bienestar, Universidad Andrés Bello, Chile. <https://orcid.org/0000-0002-2685-8991> | [frano.giakoni@unab.cl](mailto:frano.giakoni@unab.cl)

<sup>7</sup> Magíster en Ciencias de Salud, mención gestión clínica. Centro de Deportes y Recreación, Universidad Austral de Chile, Chile. <https://orcid.org/0000-0002-6328-6451> | [jose.aguilar@uach.cl](mailto:jose.aguilar@uach.cl)

<sup>8</sup> Doctor en Ciencias del Ejercicio. Facultad de Medicina, Universidad de los Andes, Chile. <https://orcid.org/0000-0001-7789-7897> | [raulurbinas@gmail.com](mailto:raulurbinas@gmail.com)

<sup>9</sup> Doctor en Educación Física y Deportes. Pontificia Universidad Católica de Valparaíso, Chile. <https://orcid.org/0000-0002-9020-5776> | [daniel.duclos@pucv.cl](mailto:daniel.duclos@pucv.cl)

## RESUMEN

El objetivo del presente trabajo es analizar el desempeño deportivo de la delegación chilena en los Juegos Panamericanos celebrados entre los años 1951 y 2023, haciendo uso de datos retrospectivos y proyectivos a través de series temporales de tiempo. Para esto se empleó un diseño cuantitativo, no experimental y longitudinal de tendencias y un método de suavización exponencial simple, que utiliza promedios históricos y que permite realizar una predicción o comportamiento futuro basado en una media ponderada de los valores actuales y de los pasados. A partir de los resultados obtenidos, fue posible concluir que, en las últimas décadas, la ubicación de Chile en el ranking de los Juegos Panamericanos se ha estabilizado en torno a un onceavo lugar, posición pronosticada para Santiago 2023. Manteniéndose condiciones similares, el desempeño deportivo general y específico no tendría un quiebre exponencial de la tendencia y los resultados no resultan favorables, específicamente en lo que respecta a la obtención de medallas de oro y la posición general de la delegación.

**Palabras clave:** Juegos Panamericanos; Rendimiento deportivo; Deporte de élite; Técnica de pronóstico; Suavización exponencial simple.

## RESUMO

O objetivo deste artigo é analisar o desempenho esportivo da delegação chilena nos Jogos Pan-Americanos realizados entre 1951 e 2023, usando dados retrospectivos e projetivos por meio de séries temporais. Para isso, foi utilizado um desenho quantitativo, não experimental e longitudinal de tendências e um método de suavização exponencial simples, que utiliza médias históricas e permite uma previsão do comportamento futuro com base em uma média ponderada dos valores atuais e passados. Com base nos resultados obtidos, foi possível concluir que, nas últimas décadas, a posição do Chile no ranking dos Jogos Pan-Americanos se estabilizou em torno do 11º lugar, posição prevista para Santiago 2023. Mantendo-se condições semelhantes, o desempenho esportivo geral e específico não teria uma quebra exponencial na tendência e os resultados não são favoráveis, especificamente em termos de conquista de medalhas de ouro e posição geral da delegação.

**Palavras chave:** Jogos Pan-Americanos; Desempenho esportivo; Deporte de elite; Técnica de previsão; Suavização exponencial simples

## INTRODUCTION

During different periods and cycles, various large-scale mega sporting events (MSE) are held around the world with profound international and national significance, generating a sense of pride and identity, facilitating social cohesion (Tejero-González, 2016), interest and connection (Duclos-Bastías et al., 2023). Nowadays, examples of mega events can be found in major fairs, festivals, exhibitions, cultural events and sporting events that are held on a regular basis and that provide an opportunity for international trade, sporting competition, cooperation and/or celebration of relations between countries (Chalkley & Essex, 1999), with a fixed duration and generally organized by a host city that sometimes includes sub-venues. To obtain the venue, a set of arguments is deployed, including the endorsement of the country's political and sports authorities, represented by its president, as appropriate, which ultimately translates into a document called the Portfolio, which responds to one of the requirements of Panam Sports, the governing body of the Pan American Games.

The awarding of the venue allows for the convening of a significant number of athletes and spectators, both local and foreign. The event is covered by a wide and diverse range of media, which allows for the transmission of emotions, the generation of inspiration, the modification of conduct and behavior in lifestyles and, of course, new learnings for society. At the same time, it requires a significant investment in infrastructure, logistics and security, in addition to the formation of a Local Organizing Committee (LOC), made up of national and local government authorities as well as the governing sports institutions of the host country and city. At the same time, it demands a broad deployment of a management model that safeguards the installation, organization, development and legacy as well as the technical process of its

athletes and their respective federations (Roche, 1994; Llopis-Goig, 2012).

In this context, Hughes et al. (2010) state that it is an opportunity to diversify, develop and value a wide range of topics linked to different types of social legacy (Carvalho et al., 2023), which includes, among others: quality of life, well-being, leisure culture, social cohesion, education, civic training, values, habits, inclusion, environment, gender, quality of services, which ultimately allow for greater citizen awareness and, therefore, a greater sports culture in communities and their territories. For their part, Preuss & Soberg (2006) highlight the opportunity to highlight the population's sense of pride, promote heritage and territorial identities, energize the socio-economic fabric and ensure that the territories considered directly and indirectly become involved and socially co-responsible in their organization and co-execution (Taks, 2013).

In addition to the above, there are the possibilities of Sponsorships, transforming sport into an important sector of the economy (Widmark & Holmgren, 2017) as well as an opportunity to promote country and territory branding strategies (place branding), as defined by Anholt (2003). In this regard, the work of Espinoza & Grigoletto (2020) concluded that, in relation to the economic impact on the host countries of the Pan American Games, they first observe an increase in unemployment rates and the existence of a high correlation in the variation of the gross domestic product (GDP) and the real GDP per capita. The above is due to the production of goods and services such as, for example, sports infrastructure, the Pan American Village, equipment, connectivity and the hiring of human resources.

In the case of the XIX Pan American Games and VII Parapan American Games to be held in

Santiago de Chile, it is a multi-sport, social and multicultural event, which also aims to generate a social, cultural, urban and educational legacy using "sustainable development" or "sustainable regeneration" to justify its celebration (Smith, 2009). The above, in addition to sports and for Santiago 2023, will include guidelines from international charters, such as some of the 17 Sustainable Development Goals (SDG), promoted by the United Nations Organization [UN] (2015). In this context, after the experiences of the 1962 World Cup, the 2014 South American Games, the 2014 Dakar Rally, the 2015 Copa América, these games, awarded in Prague in November 2017, are a challenge and an opportunity to make up for the resignation of the venue awarded by Chile in 1975 and 1987, in the context of the civil-military dictatorship, due to the economic and political scenario. The Games will be held after a complex period in terms of health and adverse inflationary conditions in the economy.

On the sporting level, it calls for delegations from 41 countries in the Americas and will grant the possibility of directly qualifying for the 2024 Paris Olympic Games and some sporting events will have the possibility of adding points or registering minimum marks for the event. Technically, in the case of Chile, it should be considered that these games will be held in the month of October, the last date of the world calendar and after a set of other fundamental competitions of global scope.

Currently, as with education, health and other areas of a country's development, there are different concepts and perspectives regarding the quality and type of success. It is declared a multidimensional, continuous and comprehensive concept that requires an internal and external self-evaluation (Machado, 2018). In this sense, it is possible to improve in different ways, both in qualitative and quantitative areas. To do so, evaluating the processes, establishing

development indexes, determining and projecting quality, also constitute a constant concern in the world of sport. In this sense, by virtue of the varied fields of analysis, sports observatories and institutes have been set up in various parts of the world, allowing for the collection of information and a growing interest in investigating aspects for success in elite athletes (Fernández et al., 2021) together with the possibility of mapping and measuring progress and processes through indicators and indexes, allowing for the understanding of improvement or deterioration, as well as the prediction of results. Considering what has been described and given the importance that these games have for the American continent, countries will measure their progress and developments in terms of elite sport, understanding the latter as the degree of possible increase in motor performance in a given sporting activity and as the result of a sports management model and the planning of a structured training program at the highest level (Aguayo et al., 2004).

For the above, forecasting models are techniques to fit an appropriate and modeled curve to historical data of a time series. With them, it is possible to establish historical parameters that can be extrapolated to predict their future development. Within these, the decomposition models overcome the linearity limitations of traditional regression models and allow predictions on series influenced by parameters such as trend, cyclicity, seasonality and random variation (Bowman et al., 2007). In particular, the Simple Exponential Smoothing (SES) method is a useful technique to smooth a time series, and is also used to obtain short-term predictions and is characterized by giving greater weight to the latest values of the series and less weight to the first ones (Aguilera, 2009). Goodwin (2010), in the field of economics, describes the simple exponential smoothing method as a way

to forecast the demand for a product in a given period. He estimates that the demand would be equal to the historical average for a period, giving greater weight to the values closer in time. In addition, he takes into account the current forecast error in the following forecasts. For the above reasons, this work has set itself the objective of analyzing the evolution of Chilean sports performance in the Pan American Games in the events held between 1951 and 2023, using retrospective and projective data through time series, using the simple exponential smoothing method.

## METHODS

This study has a quantitative, non-experimental, longitudinal trend design. Longitudinal data help to understand how a phenomenon changes over time, as they seek to measure the evolution of the individual or the characteristics of a population, which allows establishing parameters to predict their future behavior (Hernández-Sampieri & Mendoza, 2018).

### Tools

In relation to the objective of the research and the available data, as previously noted, it was decided to use the simple exponential smoothing method (Brown, 1959; 1963) which has already been applied in other research in the field of sport (Clarke, 2011; Coyne et al., 2021). The SES method is a forecasting technique, it is part of inferential statistics, it uses historical averages and allows a prediction or future behavior based on a weighted average of current and past values. This technique allows a schematic visualization of Chile's potential performance in the next Pan American Games in Santiago 2023.

The calculation of the technique is based on the following equation:

Equation 1

$$\hat{Y}_t = \alpha Y_{t-1} + (1 - \alpha) \hat{Y}_{t-1}$$

Where:

$\hat{Y}$  = Forecast for the following period

$\alpha$  = smoothing constant

$Y_{t-1}$  = actual value of the series in period t-1

$\hat{Y}_{t-1}$  = Forecast for the t-1 period

Equation 1 is based on assigning exponentially decreasing weights to past data points. Initially, an initial value  $\hat{Y}(1)$  is assigned as a starting point for the smoothing process. The above formula is then used to estimate  $\hat{Y}(t+1)$  at each subsequent period, using the observed value  $Y(t)$  and the previous smoothed estimate  $\hat{Y}(t)$ . As we move forward in time, the exponentially decreasing weights ensure that more recent data have more influence on future estimates. The value of  $\alpha$  determines the degree of smoothness of the estimates. A value of  $\alpha$  closer to 1 will give more weight to more recent data, resulting in a faster response to changes in the data. On the other hand, a value of  $\alpha$  closer to 0 will give a more balanced weight to past data, resulting in a smoother response that is less sensitive to fluctuations. The choice of  $\alpha$  depends on the nature of the data and the objective of the smoothing.

### Sample

The universe corresponds to the sporting performance of the Chilean delegation considered in gold, silver and bronze medals obtained from 1951 to 2019. Likewise, it is necessary to specify that the Chilean delegation is made up of elite athletes from the Sports Federations affiliated with the Chilean Olympic Committee, which in 2019 reached the number of 54.

### ***Source of information***

An official and open database from the online resource center of the Pan American Sports Organization (Panam Sports) was used, which has the management reports of the 18 versions of the Pan American Games held (Figure 1). To access the information, a web browser was used and the address

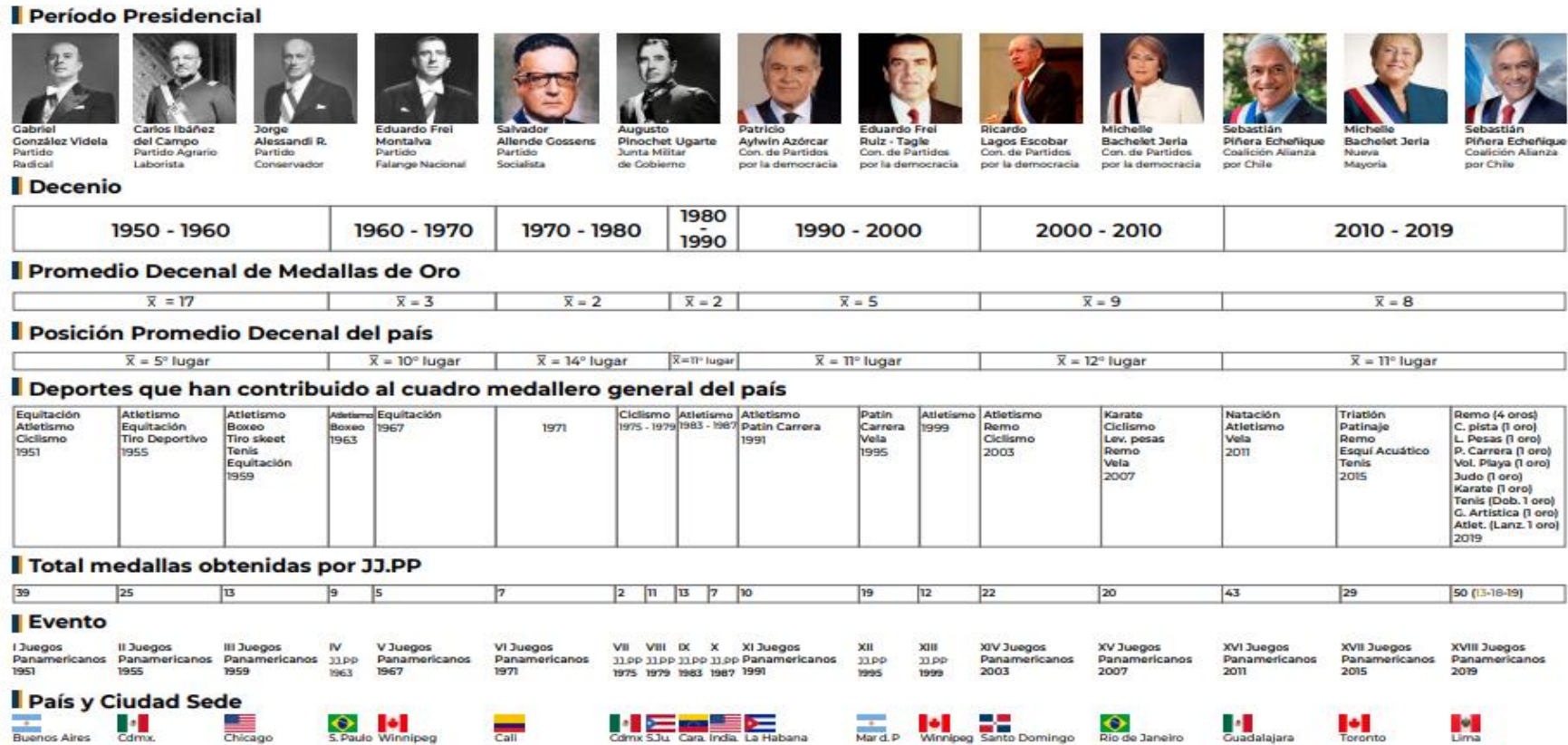
<https://www.panamsports.org/our-games/other-events/> was entered during the year 2022, then the files corresponding to the management reports of the Pan American Games from 1951 to 2019 were downloaded. A secondary data analysis was carried out with information from an official report; only the data of interest for this work were selected (Heinemann, 2008).

### ***Procedures***

The data series was entered into the Microsoft Excel program. The Alpha Constant or smoothing factor was selected, which varies between 0 and 1. Closer to 1 implies a forecast line closer to reality. Once the optimal Alpha value was obtained and then the weighted average of the current and past values, as well as the mean error and the mean absolute error, the forecast line was estimated with respect to the real values.

Figure 1

Ten-year evolution of the performance of the Chilean delegation in the Pan American Games from 1950 to 2019.



## RESULTS

Table 1 presents the estimate of the position that the Chilean delegation could obtain in the next Pan American Games in Santiago 2023, based on the model used. It should be noted that this estimate maintains a similar trend to the position obtained in past editions (8th - 10th), mainly from the 1980s onwards.

**Table 1**

*Projection of the location of the Chilean delegation in Santiago 2023.*

Decade	Place	Forecast	Error
1950-1960	5	5	0
1960-1970	10	5	5
1970-1980	14	8	6
1980-1990	11	11	0
1990-2000	11	11	0
2000-2010	12	11	1
2010-2020	11	12	-1
2020-2030		9-10	

Source: Author's elaboration.

Note: Average error = 2; Average absolute error = 2

Table 2 provides information regarding the estimation of the gold medals that Chile is likely to win at the 2023 Games (10-12), a forecast obtained from considering the medals won in the past Games.

**Table 2**

*Gold Medals Projection of the Chilean delegation in Santiago 2023.*

Decade	Gold Medals	Forecast	Error	Abs Error	$\alpha$	1,00
1950-1960	17	17	0	0		
1960-1970	3	17	-14	14		
1970-1980	2	3	-1	1		
1980-1990	2	2	0	0		
1990-2000	5	2	3	3		
2000-2010	9	5	4	4		
2010-2020	8	9	-1	1		
2020-2030		10-12				

Source: Author's elaboration.

Note: Average error = -1; Average absolute error = 3



Table 3 presents the data corresponding to the medals obtained and the results of the estimate of the total obtained by the Chilean

delegation in all editions of the Pan American Games and the forecast for the Santiago 2023 Games.

**Table 3**

*Projection of the number of medals won by the Chilean delegation in Santiago 2023.*

Year	Edition No.	Medals	Forecast	Error	Abs Error		
1951	I	39	39	0	0	$\alpha$	0,78
1955	II	25	39	-14	14		
1959	III	13	28	-15	15		
1963	IV	9	16	-7	7		
1967	V	5	11	-6	6		
1971	VI	7	6	1	1		
1975	VII	2	7	-5	5		
1979	VIII	11	3	8	8		
1983	IX	13	9	4	4		
1987	X	7	12	-5	5		
1991	XI	10	8	2	2		
1995	XII	19	10	9	9		
1999	XIII	12	17	-5	5		
2003	XIV	22	13	9	9		
2007	XV	20	20	0	0		
2011	XVI	43	20	23	23		
2015	XVII	29	38	9	9		
2019	XVIII	50	21	19	19		
2023	XIX		52				

Source: Author's elaboration.

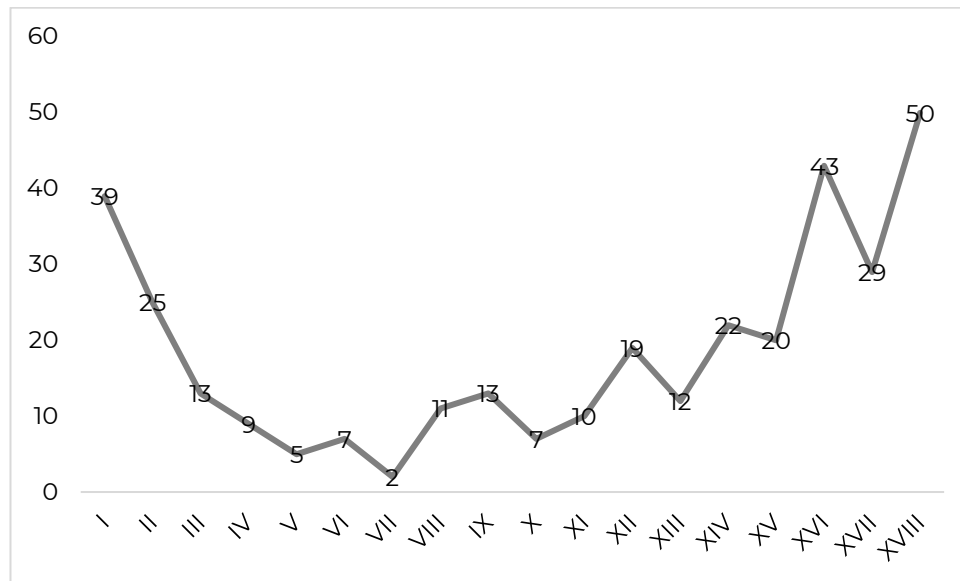
Note: Average error = -0.608; Average absolute error = 7.146

Figure 2 presents the data from Table 3 on the estimated total number of medals won by the Chilean delegation in all editions of the Pan American Games. In the graph, it can be seen that the medals won over time present a slight "U"

shape, whose base is concentrated mainly between events V and X, and then rises upwards. Thus, the estimated forecast for the next Games yields a total of 46 - 50 medals.

Figure 2

Projection of the number of medals won by the Chilean delegation in Santiago 2023.



Source: Prepared by the authors based on panamsports.org

## DISCUSSION

The objective of this work was to analyze the evolution of Chilean sports performance in the Pan American Games in the events held between 1951 and 2023, using retrospective and projective data through time series, using the simple exponential smoothing method.

To start the discussion, it is important to note in relation to the methodology used in this work, few publications have been found that have made sports forecasts in the Pan American context, such as the systematic review work on beach volleyball published by Araripe et al. (2014) from a game perspective, while in the specific case of the Pan American Games, the work of Kuper & Sterken (2012) is noteworthy, which predicted and evaluated the Guadalajara Games considering socioeconomic data of the countries. Therefore, it is not possible with this background to explain the present results of this work.

Considering the above, taking into account the analysis of data and previous scientific evidence of sports performance expressed in

different major events, especially the work published by Olderr (2003), it is possible to conclude that in recent decades, Chile's position in the Pan American Games ranking has stabilized around eleventh place, a position that could be improved or maintained depending on the performance of Lima 2019 and forecast for Santiago 2023. The above would be replicated when observing the performance displayed in relation to obtaining gold medals (10-12), also enhanced by sports such as professional Golf and Tennis and some of them that will emerge from regions. Regarding the number of medals obtained as a delegation, the forecast predicts the obtaining of around 50 medals or more, obtaining a relative improvement compared to Lima 2019. This forecast would represent a very unsatisfactory performance if we compare the position that the country has on the continent in relation to other dimensions, such as in the institutional, economic, cultural, among others.

The location of an eleventh, tenth, ninth or eighth place is far from the relative performance

that Chile had in the middle of the last century. This means that the country has been falling behind comparatively in relation to the efforts that neighboring countries have made, such as Brazil, Colombia, Argentina and Venezuela in sports, all of them with greater sporting significance, with more solid structures and, therefore, with a greater history of development. What has been described, currently has Chile in the third group of countries at the Pan American level, where the Dominican Republic, Peru and Ecuador are also found. From another perspective, the sporting performance of a country's athletes can be explained by macro factors and particularly by their micro environment (Jacques et al., 2016). In this regard, it is suggested to look at neighboring models, to analyze in depth the current Chilean high-performance system from the socio-ecological model (SEM) of Mcleroy et al. (1988), as well as the structures that generate subordination in the social construction of elite sport, both in the micro-social space and in the macro and meso-social space. It is also suggested to keep in mind the SPLISS model (De Bosscher et al., 2007) and to permanently consider the points of view, arguments and demands systematized in different town halls, forums and citizen dialogues generated in Chile from the so-called social outbreak (Flández-Valderrama et al., 2022). Finally, it is concluded that, if similar conditions are maintained, the general and specific sporting performance for the Santiago 2023 Pan American Games would not have an exponential and profound break in the trend.

From the above, it follows that in the absence of ad hoc measures, the country will only exhibit isolated cases concentrated in events of traditional sporting modalities and under this alternative, the Chilean delegation will not have any possibility of achieving a significant improvement in the Pan American positioning.

## CONCLUSION

Based on the analysis of the results, it is possible to conclude that, in recent decades, Chile's position in the ranking of the history of the Pan American Games has stabilized around eleventh place. However, based on the data derived from the last cohort, it is predicted for Santiago 2023, between 8th and 10th place as a team; between 10 and 13 gold medals, which significantly determine the position of the countries. On the other hand, a marginal improvement is noted with respect to the achievement of the total number of bronze and silver medals. Maintaining similar conditions, the general and specific sporting performance would not have an exponential break in the trend and the results are not favorable, specifically with regard to obtaining gold medals and the general position of the team.

The results are not satisfactory if the position of the country in other continental indicators is compared in relation to other dimensions such as the institutional, economic, human development, among others.

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### Address for correspondence

José Aguilar  
Magíster en Ciencias de Salud  
Universidad Austral de Chile  
Chile.

ORCID: <https://orcid.org/0000-0002-6328-6451>

Contact: [jose.aguilar@uach.cl](mailto:jose.aguilar@uach.cl)

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