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The Trickle-Up Effect: Exploring The Relationship Between Youth Sports Participation and Elite Sporting Success

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Abstract

1. **Purpose/rationale.** In response to the limited empirical research on the "trickle-up effect" this study aims to answer a fundamental question in elite sports policy literature: "Does widespread youth sport participation contribute to elite sporting success?"
2. **Design/methodology/approach**. Using 23 years of data across 29 sports in Flanders, the study evaluates the relationship between youth sport membership levels and elite sporting success through descriptive and correlation analysis.
3. **Findings.** The results indicate a modest positive relationship (r=0.15) between both variables. However, substantial differences among sports were found, which led to a four-quadrant classification: sports with (I) low participation and high success, (II) high participation and high success, (III) low participation and low success, or (IV) high participation and low success. Interestingly, in Flanders, no sports were classified in quadrant IV.
4. **Practical implications**. The classification system indicates that extensive youth participation may contribute to international success in all but category I sports. These findings indicate that elite sports policies should pay attention to youth participation.
5. **Research contribution.** This study is the first to investigate the influence of youth participation on elite sporting success across different sports, thereby challenging the assumption of a generic trickle-up effect.
6. **Originality/value**. The extensive Flemish data provide modest and conditional yet original empirical evidence supporting the trickle-up effect.

Keywords: youth sport participation; grassroots sport; elite sport success; Olympic; trickle-up effect; sport pyramid

Introduction

For over two decades, the International Olympic Committee (IOC) has assumed a direct relationship between sport for all and elite sport, captured by the double-pyramid theory (IOC, 2000). According to this theory, thousands of people participating in sports at the base will lead to a few Olympic champions. Simultaneously, the presence of these champions is expected to inspire other people to take up some form of

sport (IOC, 2000). However, there is insufficient evidence to support this mutual relationship (De Bosscher et al., 2013; Grix & Carmichael, 2012).

While the trickle-down effect, the notion that elite success stimulates general sports participation, has been investigated in several recent studies (De Cocq et al., 2021; Lion et al., 2023), there has been comparatively little empirical research on the trickle-up effect. Studies such as those by Van Bottenburg (2002) and De Bosscher et al. (2015) are among the few that examine this phenomenon. Notably, there remains a significant gap in research specifically exploring the relationship between the number of young people participating in organised sports and later elite success in that same sport. Addressing this gap is essential due to the significant practical implications for talent development, resource allocation, and policymaking. For sports policymakers, understanding the trickle-up effect could shape strategies, structures, and budgets for mass participation as well as elite sports development initiatives. If no trickle-up effect is evident, it might indicate that separating mass participation and elite sports could allow both domains to specialise and thrive independently. Additionally, if this effect does not exist, sport organisations would need to reconsider the nature of their talent identification and development policies.

To date, the notion that a broad participation base is necessary for a few athletes to reach the top is a widely accepted and often unchallenged assumption (Green, 2005; Grix & Carmichael, 2012; Seguí-Urbaneja et al., 2020). Although the IOC, government agencies, and talent development researchers view the grassroots-to-elite pathway as self-evident, the existing literature on elite sport policy rarely considers grassroots sport participation as a crucial ingredient for developing elite sports success (Bergsgard et al., 2007; Digel et al., 2006; Green & Houlihan, 2005; Green & Oakley, 2001; Oakley & Green, 2001a, 2001b). Additionally, Van Bottenburg (2002) highlighted the complexity

and ambiguity of simultaneously pursuing mass participation and elite sports objectives. Elite sport cannot simply be seen as an extension of mass participation, and high-level competition structures can exist independently of a broad participation base (Green, 2005; Van Bottenburg, 2003). Policies that prioritise either elite success or grassroots participation often conflict with the needs of the other, such as in decisions about sports infrastructure development or determining appropriate ages for specialisation. Therefore, scholars have argued that mass participation and elite sport are evolving into distinct domains, each with its own management structures, systems, and funding mechanisms (Collins et al., 2012; De Bosscher et al., 2015; Sjöblom & Fahlén, 2010). While this distinction may sometimes be seen as a beneficial natural evolution, two key arguments suggest that separating these domains could be problematic. First, most elite athletes begin their journey at youth levels of their sport. Second, talent development frameworks typically emphasise foundational skill development in the early stages of youth participation because crucial motor skills are best developed at young ages (Balyi & Hamilton, 2004; Gulbin et al., 2013). For instance, Balyi and Hamilton (2004) identified ages nine to twelve as critical for general motor skill development including coordination, posture, balance, and flexibility. These skills, along with perceptual and cognitive skills, form the basis of athletic success (Martindale et al., 2005; Purcell et al., 2005; Zahradník & Korvas, 2012) which in turn underscores the critical role of youth participation in the development of elite athletes.

Given these insights and general assumptions, the trickle-up effect remains an under-researched topic within elite sport policy and talent development literature, particularly at a sport-specific level. This gap, combined with the practical challenges of balancing mass participation and elite performance objectives, highlights the need for empirical investigation to assess whether the trickle-up effect is evident in sport-specific

contexts. Focusing on sport-specific membership flows, this paper aims to examine the relationship between youth sport participation and elite sport in Flanders. It provides a snapshot of the broader landscape of factors influencing elite sport success by analysing the correlation between youth sport memberships and international sporting success in 29 sports. However, more detailed questions about the conditions under which the trickle-up effect occurs and which other factors influence elite sport success fall outside the scope of this study. This paper contributes innovative empirical data to address the question: "Does widespread youth sport participation contribute to elite sporting success?"

Literature

Elite sports policy literature versus talent development literature

In elite sports policy literature, the importance of grassroots sport participation for elite sporting success is rarely emphasised, with one of the few exceptions being the 2008 Sport Policy factors Leading to International Sporting Success (SPLISS) study, which addressed this through a global literature review (De Bosscher et al., 2008). This perspective aligns with talent development literature, where athlete pathway models typically begin at the grassroots level, starting with initiation or foundational stages: the transition model of Bloom (1985), the Long-Term Athlete Development Model of Balyi (2001), the Holistic Athletic Career Model of Wylleman and Lavallee (2004), the Developmental Model of Sport Participation of Côté et al. (2007), the Attraction, Retention/Transition and Nurturing model of Sotiriadou et al. (2008), and the Foundation Talent Elite and Mastery model of Gulbin et al. (2013).

Trickle-up effect research

The limited research that focussed on the trickle-up effect had mixed results. While Van Bottenburg (2002) and De Knop and De Bosscher (2002) showed evidence supporting the trickle-up effect, Stewart et al. (2004) and Green (2005) questioned its validity. The most extensive international studies that investigated the trickle-up effect, among other policy factors, were the SPLISS studies. The second SPLISS study (De Bosscher et al., 2015) investigated sport participation (Pillar 3) in 15 nations on three levels: physical education opportunities, general levels of sport participation outside schools, and the quality of sports clubs (De Bosscher et al., 2015). This study found no significant correlation between these factors and the international success levels of the nations involved. The authors suggest that researching at a sport-specific level could be insightful, as different nations specialise in different sports, and no single nation dominates all Olympic sports (De Bosscher et al., 2003). Finally, Seguí-Urbaneja et al. (2020) were the first to investigate the sport-specific trickle-up effect with a lagged effect of maximal four years, finding a positive correlation between mass participation and elite success in basketball, tennis, and triathlon in Spain. Overall, it is essential to recognise that these scholars have employed different methods to define sporting success.

The different methodologies used in the previous studies resulted in inconsistent findings, which prevented definitive conclusions about the existence or otherwise of the trickle-up effect. Additionally, three main gaps remain in the literature. Firstly, these studies examined the supply function from mass participation to elite sport primarily at national levels, leaving the relationship at sport-specific level insufficiently explored. Secondly, all studies focused on mass participation among both adults and minors, overlooking that talent development pathways almost exclusively start from youth

athletes (De Bosscher et al., 2023). Children and young people are the essential foundation for elite sports and, therefore, the target population for investigating the trickle-up effect (Côté & Hancock, 2016; Ford et al., 2009; Green, 2005). Third, as the development of talent takes time, the trickle-up effect will only manifest itself after a lag (De Bosscher et al., 2023; De Bosscher et al., 2015). Consequently, there is a lack of studies using long-term data on youth sport to investigate the trickle-up effect.

Evaluating the trickle-up effect: four statements

The study targets these three gaps in knowledge to investigate the trickle-up effect systematically. The theory guiding this study is adapted from Van Bottenburg's (2003) three statements for investigating the trickle-down effect, i.e., the assumption that elite success encourages greater participation at grassroots level. The three statements were applied to the trickle-up effect: (1) Success should increase more significantly after an uplift in grassroots membership than the growth observed before the membership uplift (longitudinal perspective). (2) Success should be more pronounced in this specific sport compared with others without similar levels of membership (sport-specific comparison). Moreover, (3) success should be greater than in other countries in the same sport with lower participation levels (international comparison).

Additionally, a supplementary criterion from Böhlke and Robinson (2009) was added. These authors acknowledged that a nation could be successful in a sport due to a single talented athlete, but this does not indicate a systematic production of successful athletes. Therefore, beyond recent achievements, consistent historical success is needed to demonstrate the trickle-up effect.

While the third criterion, comparing success trends with other nations, could assess sport-specific or nation-specific influences, this aspect falls beyond the study's

scope due to the fixed nature of international competitive success. An increase in market share by one nation will inevitably lead to a decrease in the market share of others.

Current research on the trickle-up effect is insufficient and inconsistent, with a particular dearth of evidence at the sport-specific level, especially concerning youth participation. This study, therefore, makes a modest contribution to the academic literature by exploring the relationship between youth sport participation and sporting success in all Summer Olympic sports using the region of Flanders[1] in Belgium as a case study. It addresses crucial gaps by comparing different sports and incorporating 23 years of time series data to analyse youth sport participation and elite sport success trends in Flanders.

Materials and Methods

Data Collection

Since 2000, reliable data on elite sporting success and youth memberships in Flanders have been gathered consistently and have been available for public consumption.

Elite Sporting Success

This study uses the "Elite Sports Index" (ESI) methodology that Sport Vlaanderen (the regional sports administration body in Flanders) applies to analyse longitudinal elite sporting success. This sophisticated index calculates a nation's sporting success at an aggregate level and within specific sports. The index is inspired by the method of De Bosscher et al. (2013) which had remarkable similarities with the UK Sport World Sporting Index, the national sporting index developed by Sport Canada, and the elite sporting index developed by the Dutch National Olympic Committee*National Sports Federation (NOC*NSF).

The ESI provides a detailed and nuanced evaluation of international sporting success, by combining results from the Continental Championships, World Championships, and Olympic Games. The index is a constantly updated index summarising an Olympic period of four consecutive years, including one Summer Olympic Games and one Winter Olympic Games. The ESI employs a weighted approach to measure the evolution of international sporting performances in specific disciplines and specific countries, accounting for the importance and frequency of sporting competitions. Four considerations are made to weigh the results in the ESI score. First, while the index accounts for the top eight places, medals get a higher weight (factor = 3) than top eight places (factor = 1). Second, the index adjusts for the importance of events, with global events such as the World Championships and Olympic Games carrying greater weight (factor = 2) than Continental Championships (factor = 1). Third, team sports are assigned a higher importance (factor =3) than individual sports (factor = 1) because a nation needs more elite-level athletes to have a world-class team. Lastly, the index considers the frequency of championships, with events occurring once in four years (factor = 4), once in two years (factor = 2), or once in three years (factor = 1.33) holding more weight than annual championships (factor = 1). For example, using this method, the silver medal of the Belgian men's field hockey team in Rio 2016 yielded 72 ESI points. It is a top-three ranking, so the index starts with a factor of 3. Since it is an international event, this is multiplied by a factor of 2. Because it is a team sport, an additional factor of 3 is applied. Finally, because the Olympic Games occur once every four years, the total is multiplied by a factor of 4. The total index points are calculated by multiplying all these factors (3 x 2 x 3 x 4). This resulted in a total score of 72 index points. The points for this medal (among other

sporting successes) are allocated to the four-year periods that contained the year 2016: 2013-2016, 2014-2017, 2015-2018, and 2016-2019.

Using this method, the ESI was calculated to assess the performances of all nations in all Olympic sports from 2000 until 2022. The nation-specific ESI for Flanders is derived from Belgium's ESI score. The score for Flanders comprises performances of individual athletes and teams affiliated with the Flemish Community.

Aside from the total points, the ESI is also used to calculate market share percentages by comparing the obtained ESI score with the total obtainable ESI points. According to Shibli et al. (2013), the metric of “market share” offers a more comprehensive view of performance. It enables meaningful like-for-like comparisons between sports and across different periods. For example, in judo, in the 2013-2016 period, Flanders collected 41 ESI points out of the 4,480 ESI points available, meaning that Flanders won 0.91% of the success available in that timeframe. Market share estimates are particularly relevant in the sports context due to the dynamic nature of the number of competitions and the diversity of events over time. For example, the Olympic swimming discipline had 26 events in 1980 and has grown to 37 events in 2020, which means that, in absolute numbers, a higher number of top eight places can be obtained. Further, in the context of this study, market share values serve as a valid basis for equitable comparisons across different sports. These calculations acknowledge the inherent discrepancies in the number of medal-winning opportunities between sports; for example, the Tokyo Olympics featured 35 swimming events but only two football events. While Flanders, in the 2013-2016 period, won 36 ESI points in football and 126 ESI points in swimming, the market share values of 2.11% in football and 1.14% in swimming show that the opportunities for success differ considerably between sports.

Market share values ensure a standardised approach that accounts for disparities between periods and sports and enables meaningful like-for-like comparisons.

Youth Memberships

While finding a good measurement tool for international sporting success has proven to be a complex challenge, finding relevant and comparable data to measure mass participation has also proven to be difficult (De Bosscher et al., 2013; De Bosscher & Van Bottenburg, 2010). This study uses youth memberships of the national federations in each sport as a proxy for youth participation. It is noteworthy that comprehensive and reliable data regarding non-organised youth sports participation in Flanders is unavailable. Consequently, federation membership data, which exclusively capture organised sports participation, are used to quantify youth sports participation. As most elite athletes have their roots in organised participation and sports clubs (De Bosscher et al., 2015), these membership data are a good starting point for the analysis of the trickle-up effect. The sport-specific membership data were collected routinely and consistently by Sport Vlaanderen for 23 years (2000-2022). Individuals aged up to 18 were categorised as youth members for this study.

Consistent with the concept of market share applied to elite sporting success, a parallel approach was employed to assess youth participation. Because the general youth population numbers in the age category from 0 to 18 years in Flanders increased by 6%, from 1,295,420 in 2000 to 1,369,404 in 2022, a metric was devised to describe a sport's relative share of the total Flemish youth population. These scores offer valuable insights into the growth of a particular sport, adjusted for the concurrent increases in the general population. For example, athletics in Flanders had 18,494 youth members in 2015 and 18,997 youth members in 2021. While the absolute numbers increased with 500 youngsters, at both time frames, it equated 1.40% of the youth population in

Flanders, meaning no growth other than would have been expected via the organic growth of the youth population. These percentages facilitate cross-national comparisons, enabling a more nuanced understanding of engagement in youth sport across different nations.

Participation data and elite sport success scores were gathered consistently over 23 consecutive years (2000-2022)[2] in 29 Summer Olympic sports, enabling comprehensive longitudinal analysis to be conducted. The dataset was extensive, comprising 586 observations of membership data and 521 data points for the ESI score. All 29 federations have between 7 and 20 data points for the ESI score (each constructed over four years) and a maximum of 23 data points for the youth membership data (one federation is limited to 4 data points). Descriptives for these data points are provided in Table 1.

[Table 1 near here]

Data Analysis

The data analysis process encompassed three key stages: (1) an exploration of absolute data, (2) the calculation of correlation coefficients, and (3) a comparison across sports. In the initial exploration stage, descriptive statistics and graphical representations describe annual changes and time series trends in sport-specific youth participation numbers and elite level sporting achievements. These figures were used to observe whether increases in youth memberships are followed by increases in elite sporting success, as described in the first statement of Van Bottenburg (2003).

In the second stage, by employing Pearson's correlation coefficients, the study assessed the association between annual youth memberships and annual ESI scores for all sports combined and for each sport individually. These coefficients measured the associative relationship between variables, indicating changes occurring in the same

direction (positive correlation) or opposite directions (negative correlation). Given the argument that a possible trickle-up effect will manifest itself over an extended period (De Bosscher et al., 2015), the study examined whether youth memberships in a given year (X) were significantly correlated with success in the year X and also in subsequent years (X+4, X+8, and X+12). The lag duration is likely to vary from sport to sport, as peak performance ages are largely different. Therefore, the study investigated multiple lag times, the largest of which contained three Olympic cycles. The statistical significance threshold was set at $p < 0.05$. The correlations provide the requisite data to analyse the first statement of Van Bottenburg (2003).

The final stage of the analysis consists of a comparison across sports, as this is proven relevant by the second statement of Van Bottenburg (2003). While it is useful to analyse correlations between annual data of youth memberships and sporting success for every sport individually (as done in the previous phase), it is not useful to use annual data to compare different sports because of the unpredictability of the fluctuations between them. To establish whether sports with a broad youth participation base have more international success than sports with a lower participation base, it is necessary to consider the 23-year measurement period holistically. As derived from Böhlke and Robinson (2009), a nation must demonstrate not only recent sporting success but also a consistent history of success in a specific sport. The timeframe of 23 years gives a sound representation of the historical context in Flanders and reflects a comprehensive and long-term perspective. Therefore, the averages of the market share percentages and population proportions over the 23 years for each sport were used to identify the sports where increased levels of youth participation are associated with increased success. Over the 23 years, the participation rate for athletics in Flanders ranged from 0.81%

(2000) to 1.54% of the youth population (2018), with an overall average value of 1.25%.

Results

Exploration of Data

Youth sport participation in Flanders varies significantly, ranging from 74 members in weightlifting (2019) to 168,402 members in football (2019). The sports with the highest youth participation rates are football (11.45%), gymnastics (6.40%), tennis (4.10%), and swimming (2.24%).

Over the 23 year measurement period, Flanders achieved no success in climbing, diving, handball, modern pentathlon, surfing, water polo, and wrestling. The highest scores on the Elite Sports Index (ESI) were observed in cycling (ESI 272 in 2019-2022), field hockey (ESI 232 in 2017-2021), and athletics (ESI 179 in 2019-2022). The ESI scores for most of the 29 sports examined displayed random fluctuations over the years and do not show a general trend. Some sports demonstrated significant increases in their success rates, such as basketball, boxing, gymnastics, and field hockey. By contrast, judo, fencing, and tennis show markedly decreased success rates during the measurement period.

Line graphs were used to visualise the trends in youth memberships and the Elite Sports Index scores for all sports and are provided in a supplementary file. Figure 1 showcases four distinct sports in Flanders, each demonstrating varying relationships between youth memberships and the ESI score. The graph for gymnastics indicates an increase in youth memberships alongside an increase in sporting success. In judo, the overall picture shows a decline in youth memberships and success, with an upward trend starting in 2019. There is a general decrease in success in tennis despite an

increase in memberships. Lastly, the graph for athletics illustrates the complexity of the relationship between youth sports memberships and elite sporting success, whereby the ESI score fluctuates significantly over time, and changes in youth membership numbers cannot explain these fluctuations.

[Figure 1 near here]

After examining the graphs for 29 Olympic Summer sports for which both youth participation and success data were available, it is evident that identifying the existence or otherwise of a trickle-up effect is subjective and heavily nuanced. The figures do not provide compelling evidence that Van Bottenburg's (2003) conditions for a trickle-up effect to be demonstrated are present in the Flanders' data. However, analysing the trends on a sport-specific basis is arguably more valuable and can be investigated further using correlational analysis.

Correlational Analysis

Correlational analysis evaluated whether the assumption that higher youth participation is associated with a higher level of elite sporting success is valid. Table 2 provides an overview of all correlation coefficients between youth memberships in year X (in percentages) and success scores (ESI) (market shares) in the subsequent years X, X+4, X+8, and X+12. The correlational analysis was performed first on an aggregate level (all sports combined) and second on every sport individually. Across all sports, the correlation between youth memberships and elite sporting success was significant at all time points X, X+4, X+8, and X+12 but only showed a small effect size (Pearson's correlation = 0.16; 0.16; 0.21; 0.15; with all p-values below 0.001) (Field, 2013). These results highlight that grassroots sports in Flanders are associated statistically with elite sporting success, albeit to a modest extent.

[Table 2 near here]

When looking at the 29 sports individually, there are differences in the correlation coefficients between the sports, and these correlations also demonstrate fluctuating patterns, as detailed in Table 2. When investigating the trickle-up effect, three sports consistently show significant correlations across all lagged periods: cycling, gymnastics, and triathlon. These sports simultaneously increase youth memberships and elite sporting success levels. Although several sports display some significant correlations, in many sports, the fluctuating nature of the ESI scores makes it challenging to establish a trickle-up effect that meets Van Bottenburg's (2003) conditions.

In conclusion, the correlational analysis supported the existence of a trickle-up effect at a general level but shows simultaneously that this is not apparent in all sports. Consequently, it was necessary to delve deeper into the data to identify differences between sports.

Comparison Across Sports

To answer the question of whether sports with a broad youth participation base have had more international success than sports with a lower participation base, the mean values over the whole measurement period were compared (Table 3). These sport-specific numbers show the historical context of each sport over the 23 years, 2000-2022.

[Table 3 near here]

Field hockey (5.28%), equestrian (2.88%), cycling (2.10%), and triathlon (2.07%) emerged as the sports in Flanders with the highest market share scores. Youth participation rates in Flanders exhibited a broad range spanning from 0.01% in weightlifting to 11.5% in football. To understand which sports have similar patterns of youth participation and success, sports were categorised into high and low levels of participation and success, for which a valid method was developed using cut-off values.

The cut-off values are used to classify all sports into four categories: (a) sports characterised by both a low youth participation and low success, (b) sports with low youth participation and high success, (c) sports marked by high youth participation and low success, and (d) sports featuring high scores for both youth participation and success. The cut-off values are used to divide the high and low levels. The following sections explain how the cut-offs were determined and implemented.

Cut-off Youth Memberships

In data that contain outliers and extreme values (such as the football youth participation numbers), it is best to opt for a trimmed mean that increases the robustness of the analysis. Therefore, the annual 5% trimmed means of the youth participation numbers in 2019, 2020, 2021, and 2022, the only years in which data for the 29 federations included were available, was the preferred option for the cut-off value for participation rates. In those four years, respectively, an average of 13,370 (2019), 13,067 (2020), 13,419 (2021), and 13,717 (2022) under 18s were members of one of the 29 sports federations, constituting approximately 1% of each year's Flemish youth population. Hence, 1% of the population was designated as the threshold for defining high and low levels of youth participation in a sport. Sports with a youth participation rate above 1% were classified as high participation sports, and sports with a participation rate below 1% were classified as low participation sports.

Cut-off International Success

Determining a value to distinguish between high and low success levels proved challenging. The approach of this study involved seeking a predictive score for Flanders' success level that also considered what other competing nations could achieve. Previous research efforts have explored international predictive models that

estimate success levels across nations (Andreff & Andreff, 2015; Bailey, 2005; Bernard & Busse, 2004; Clephas et al., 2022; Condon et al., 1999; De Bosscher et al., 2008; De Bosscher et al., 2003; Halsey, 2009; Schlembach et al., 2022; Shibli et al., 2012).

Empirical studies have demonstrated that a nation's success at the Summer Olympic Games significantly depends on its wealth (GDP/capita), population size, and historical political context of being or formerly being a communist country (dummy variable). These three variables accounted for 52% of the top eight placements in the 2012 Summer Olympic Games in London (De Bosscher et al., 2015). In this study, the same methodology as described in De Bosscher (2007) and De Bosscher et al. (2015) was applied, by utilising the three explanatory factors in a regression analysis to explain and predict the market share of the top eight places in the 2020 Olympic Games. Like the previously cited methodologies, all data in this study underwent a logarithmic transformation to address outliers and exponential distributions.

The analysis revealed that the three variables explained 58.5% of the variance. Using the coefficients, a formula was constructed to compute the estimated success levels of different nations and/or regions. Regression analysis identified the formula as follows:

$$Ln(MarketShare(TOP8ofOlympics2021)) =$$

$$.904\ (Ln(GDP_{capita})) + .497(Ln(Population)) + .661\ (Communism) - 23.00 \quad (1)$$

This formula estimates Flanders' success levels based on its macroeconomic factors: GDP/capita and population size. As of 2022, Flanders had a population of 6,698,876 inhabitants (Statbel, 2022) and a Gross Domestic Product (GDP) of 43,336 Purchasing Power Parity per capita (Statistiek Vlaanderen, 2022). According to the formula, Flanders should attain a market share of 0.39%. This value was adopted as the

457 cut-off point to determine whether Flanders achieves a high or low level of success in a
458 specific sport.

459 *Classification of Sports*

460 Combining both cut-off values allowed the categorisation of sports into four distinct
461 groups in a 2x2 matrix. Figure 2 gives a visual representation of all sports and presents
462 the cut-off lines that divide the sports into three out of the four categories. This figure
463 shows considerable variations between sports in the same group, especially in
464 categories I and II. The figure also shows that certain sports are close to the cut-off
465 score and their classification should therefore be interpreted cautiously (e.g., swimming
466 and volleyball have a market share of 0.41%; field hockey has a participation rate of
467 1.02%).

468 [Figure 2 near here]

469 Table 4 also presents the four groups of sports. Of the 29 classified sports, 18 sports
470 (62.1%) were classified as having high success over the measurement period (groups I
471 and II), of which 11 sports (37.9%) also had high levels of youth memberships (group
472 II).

473 [Table 4 near here]

474 These eleven sports show some evidence of the trickle-up effect: field hockey,
475 cycling, equestrian, judo, tennis, football, athletics, basketball, gymnastics, swimming,
476 and volleyball. It is worth noting that no sports are classified within group IV.
477 Consequently, all sports with relatively high levels of youth memberships also
478 demonstrate a relatively high level of success, providing empirical evidence to support
479 the assumption of the trickle-up effect.

480 By contrast, group I shows seven sports (triathlon, golf, sailing, rugby sevens,
481 skateboarding, taekwondo, and rowing) in which high levels of success were achieved

despite low youth membership levels. These sports reflect the finding that extensive (organised) youth participation is not necessary to create international success and that elite sport can also develop in other ways than through a pyramidal structure.

In the remaining 11 sports (group III), Flanders did not have high levels of youth memberships and did not achieve high levels of success. These sports are less popular among Flemish youth and are less valuable to evaluate the trickle-up effect in this context.

Discussion

This study addressed a crucial question for elite sport policymakers: "Does widespread youth sport participation contribute to elite sporting success?" by examining 29 sports in Flanders. The research design was based on three out of four statements proposed by Van Bottenburg (2003) and Böhlke and Robinson (2009). The results demonstrate a statistically significant correlation between youth memberships and elite sporting success, suggesting that a broader participation base might increase the likelihood of achieving elite success. However, the effect size reveals that this correlation is relatively small (Pearson's correlation coefficient lies between 0.15 and 0.21), indicating limited practical implications. Further analysis revealed that all 11 sports with relatively high youth participation, also showed relatively high success rates. Therefore, this study confirms that a broad participation basis should be considered as a policy determinant for developing elite sporting success.

However, this is not a universal principle across all sports and the results emphasise the need to avoid generalised conclusions about the existence of a trickle-up effect. Sport-specific differences resulted in the categorisation of 29 sports in Flanders into three distinct groups. Two groups of sports (II and III) aligned with the trickle-up effect, suggesting that higher levels of youth participation have led to elite success. It is

remarkable that all sports in group II are highly internationalised sports, as indicated by the multitude of participating nations in international competitions (Van Bottenburg, 2001). It seems plausible that the greater the global spread of a particular sport, the higher the standard will be at elite level, and the more difficult it will be to achieve elite success in that sport without a broad participation base. Therefore, the intense global battle for medals has led to well-developed participation structures worldwide, which consequently are replicated in Flanders.

By contrast, in the seven sports in group I – triathlon, golf, sailing, skateboarding, rugby sevens, taekwondo, and rowing – relatively high levels of success were found despite relatively low levels of youth participation. Four sport-specific characteristics can possibly explain these results: late-starting sports, high-cost sports, largely unorganised sports, or sports influenced by migrant populations. First, triathlon and rowing are late-starting and specialisation sports featuring a minimal youth participation base (De Bosscher et al., 2023). Success is often achieved at an older age and frequently relies on the principle of talent transfer (Green, 2005). Second, golf and sailing require specific facilities and have relatively high equipment and participation costs, which means that they are participated in select groups of people only (Hayman et al., 2011; Henriksen et al., 2010). Third, skateboarding, associated with a particular lifestyle, attracts many unregistered participants in Flanders. Because the study only captured memberships in an organised sports context, the youth memberships of skateboarding in this study will inevitably underestimate actual youth numbers. Finally, taekwondo and rugby sevens are not commonly practised in Flanders but have produced international success. However, some of these talents arise from migrant populations (outside Flanders) and can potentially be derived from high youth participation in their country or region (Wallonia) of origin. Attention should be paid to the seven sports in

group I as they demonstrate that extensive (organised) youth participation is not a prerequisite for international success.

In addition to these sport-specific characteristics, it can be assumed that various other factors, including elite sports funding, talent identification, and talent development strategies, influence the relationship between youth sport participation and elite sporting success. In Flanders, the government targets its elite sport funding on a subset of approximately 25 sports (De Bosscher et al., 2019). There are significant similarities between these funding levels and the four-group categorisation in this paper, which show that elite sports funding and high participation in Flanders are closely related and sport-specific. This finding adds another layer to the complex relationship between grassroots sports and elite sports. Because funding, youth sport participation, and elite sporting success are interconnected, scientifically determining cause-and-effect relationships with current data is challenging, but all the more scientifically and policy-wise relevant.

In Flanders, extensive youth sport participation appears to contribute to elite sports success. Sports with high youth memberships consistently achieve high levels of success, and no sports fall into the category of high participation with low success (quadrant IV of Figure 2). These findings confirm the need for policymakers to address the growing separation between mass participation and elite sport development. The results support the arguments outlined in the introduction concluding that, to develop elite sports, we must maximise the potential of youth sport development. To strengthen these conclusions, future research should investigate not only the quantity of youth memberships but also the quality of youth sports delivery. Investigating the role of sports clubs and examining how federation policies address youth sport development could provide deeper insights into the trickle-up effect.

Some limitations have hindered the potential to answer the research question as fully as we would have liked. First, the methods used can only present an initial pragmatic view of the trickle-up effect because although investigating the phenomenon through membership data and the Elite Sports Index is valid, it does not describe the full complexity of the relationship. Elite sporting success could also arise from non-organised informal sport participation, or autonomous elite sport developmental models, which focus only on talent transfer from outside a sport's participants base (De Bosscher & Van Bottenburg, 2010). However, because this study concurs with the earlier stated view that a trickle-up effect if it exists, would mainly occur through sports clubs and sporting competitions (Van Bottenburg, 2003), the methods used provide valuable new insights into the trickle-up effect at a sport-specific level.

Second, this study was based on only three out of four statements of Van Bottenburg (2003) and Böhlke and Robinson (2009). An international comparison was not incorporated in the study, which limits the generalisability of the sport-specific findings to contexts beyond Flanders. Future research should include international comparative research that compares specific sports in different nations.

Another limitation of this study is its use of bivariate correlation to examine the trickle-up effect. Correlation coefficients do not reveal causal relationships but can provide valuable new insights into the previously unexplored trickle-up effect. In future research, techniques such as employing panel-data statistics, multivariate regression analysis, or a SEM model, which allows for the evaluation of causal relationships and can include and control for other influencing factors, are recommended (Frick & Wicker, 2016).

A final limitation arises from using cut-off scores to determine high and low levels of success. The regression, based on GDP/capita and population sizes, only

582 explains 58.5%, there are other factors at play. Therefore, the categorisation into low
583 and high levels of success should be interpreted cautiously and considered an indicative
584 measure. Nonetheless, this study's categorisation of sports by participation levels and
585 success levels retains significant value, fostering insightful comparisons across different
586 sports.

587 Ultimately, it is important to emphasise that numerous other explanatory
588 variables exist that might also explain international success. These variables need
589 consideration for a fuller understanding of any causal trickle-up effect. As described in
590 the SPLISS studies (De Bosscher et al., 2008; De Bosscher et al., 2015), eight policy
591 factors aside from participation can influence international sporting success: financial
592 support, governance and organisation, talent identification and development, athletic
593 career support, training facilities, coaches, competitions, and scientific research and
594 innovation. All these factors, whether working in isolation or concert, make it extremely
595 challenging to investigate the relationship between grassroots sport and elite sport.
596 While this study confirms the importance of youth sports participation in the creation of
597 international success, it is only a first step towards a deeper analysis of the talent
598 development pathway from an elite sport policy perspective. Future research should
599 include additional factors (such as e.g., elite sports funding, talent identification
600 strategies, and talent development strategies) that might affect elite sporting success and
601 incorporate an international comparison.

602 **Conclusion**

603 The correlational analysis across 29 sports in Flanders revealed a positive correlation
604 between youth membership numbers and international sporting success but showed only
605 small effect sizes. Additionally, the study's results show considerable variations in the
606 correlations between different sports. After a classification into four groups of sports,

the study demonstrates that high youth participation is associated with high levels of success across all sports. Conversely, seven sports with low youth participation in Flanders, still managed to achieve notable international success. This finding could be due to four sport-specific characteristics: late starting ages, high-cost sports, largely unorganised sports, and sports influenced by migrant populations. Future research should extend these sport-specific findings to comparisons with other nations and include a broader range of explanatory variables to identify the reasons why, in certain sports, a broad youth participation base is, or is not, related to achieving elite sport success.

1 Belgium operates as a federal state comprised of distinct communities and regions. Belgium recognizes three communities based on its official languages: the Flemish (Dutch-speaking) Community, the French Community, and the German-speaking Community. The complexity of Belgium's federal state structure gave rise to regional sports bodies in Flanders (Sport Vlaanderen) and Wallonia (Adeps). Athletes and teams representing the Flemish and French Communities compete at the elite level as Belgium.

2 The success data for 2020 repeat the results from 2019 due to the cancellation of almost all competitions caused by the COVID-19 pandemic.

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All authors declare that they have no conflicts of interest.

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Appendix

Appendix A. Relationships between youth memberships and Elite Sports Index in all 29 sports

Table 1. Key variables: data points and descriptives (minimum and maximum) for each specific sport.

	Annual youth memberships			Annual moving Elite Sports Index		
	Data points	**Minimum**	**Maximum**	**Data points**	**Minimum**	**Maximum**
Archery	2002-2022	178	542	2000-2022	0	9
Athletics	2000-2022	10,523	20,660	2000-2022	40	179
Badminton	2000-2022	4,431	9,657	2000-2022	0	12
Basketball	2002-2022	21,130	28,407	2000-2022	0	78
Boxing	2017-2022	720	1,219	2000-2022	0	13
Canoe-Kayak	2000-2022	563	992	2000-2022	5	60
Climbing	2009-2022	1,214	2,330	2013-2022	0	0
Cycling	2002-2022	2,738	38,918	2000-2022	50	272
Equestrian	2000-2022	8,821	28,380	2000-2022	10	111
Fencing	2002-2022	321	901	2000-2022	0	26
Field hockey	2013-2022	9,027	16,862	2000-2022	12	232
Football	2009-2022	136,801	168,402	2000-2022	0	84
Golf	2002-2022	2,152	3,957	2010-2022	0	9
Gymnastics	2000-2022	57,847	105,334	2000-2022	0	93
Handball	2000-2022	2,862	4,401	2000-2022	0	0
Judo	2000-2022	10,491	16,794	2000-2022	24	162
Karate	2000-2022	5,013	7,267	2013-2022	0	1
Rowing	2000-2022	417	553	2000-2022	0	51
Rugby sevens	2000-2022	581	2,733	2010-2022	0	16
Sailing	2000-2022	5,543	9,343	2000-2022	20	53
Shooting	2002-2022	178	542	2000-2022	0	8
Skateboarding	2002-2022	834	3,494	2013-2022	0	8
Swimming	2000-2022	23,147	37,447	2000-2022	3	126
Table tennis	2000-2022	1,597	2,810	2000-2022	0	5
Taekwondo	2000-2022	1,506	3,298	2000-2022	0	37
Tennis	2000-2022	36,933	58,653	2000-2022	1	60
Triathlon	2000-2022	217	1,066	2000-2022	0	54
Volleyball	2000-2022	18,107	22,426	2000-2022	0	32
Weightlifting	2019-2022	74	123	2000-2022	1	13

Table 2. Immediate and lagged correlation coefficients between youth memberships (Memb.) and success (ESI) in all sports

Pearson's correlation[a]	Memb. year X & ESI year X	Memb. year X & ESI year X+4	Memb. year X & ESI year X+8	Memb. year X & ESI year X+12
OVERALL	**.16*** **	**.16*** **	**.21*** **	**.15*** **
Archery	-.26	-.36	.53	.19
Athletics	.11	.08	-.41	.49
Badminton	.19	.45	-.48	-.33
Basketball	.10	-.28	-.43	-.62
Boxing	.52	/[b]	/[b]	/[b]
Canoe-Kayak	-.24	.39	.32	.26
Cycling	.41	.88***	.83***	.74*
Equestrian	-.69***	-.67**	-.08	.19
Fencing	-.87***	-.50*	.29	.41
Field hockey	.97***	.95**	/[b]	/[b]
Football	.67**	.44	-.71	/[b]
Golf	-.54	.01	.72*	.16
Gymnastics	.80***	.68**	.76***	.83**
Judo	.71***	.74***	.16	-.67*
Karate	-.36	.12	.25	-.01
Rowing	-.31	.30	-.06	-.33
Rugby sevens	.58	.07	.87**	.59
Sailing	.04	-.59**	-.43	.95***
Shooting	-.37	-.22	.20	.72*
Skateboarding	-.03	.40	.54	-.75
Swimming	.62**	.54*	-.14	-.64*
Table tennis	-.54*	.29	-.66**	.29
Taekwondo	.69***	.29	.52*	.03
Tennis	.27	-.55*	-.21	-.82**
Triathlon	.22	.54*	.96***	.97***
Volleyball	.43	-.59**	-.39	.73*
Weightlifting	.75	/[b]	/[b]	/[b]

[a] No success was obtained by climbing and handball.

[b] insufficient data for correlation

*p < .05 **p < .01 ***p < .001

Table 3. Percentage of youth (-18) population that participates in a sport and market share of the sport (mean of 23 years)

	% youth participation (mean)	Market share ESI (mean)
Archery	.03%	.33%
Athletics	1.25%	.66%
Badminton	.59%	.16%
Basketball	1.69%	.74%
Boxing	.07%	.03%
Canoe-Kayak	.06%	.34%
Climbing	.13%	.00%
Cycling	1.45%	2.10%
Diving	No data	.00%
Equestrian	1.50%	2.88%
Fencing	.06%	.07%
Field hockey	1.02%	5.28%
Football	11.45%	1.68%
Golf	.24%	.89%
Gymnastics	6.40%	.44%
Handball	.27%	.00%
Judo	1.05%	1.23%
Karate	.43%	.06%
Modern pentathlon	No data	.00%
Rowing	.04%	.42%
Rugby sevens	.11%	.69%
Sailing	.51%	.85%
Shooting	.03%	.03%
Skateboarding	.12%	.65%
Surfing	No data	.00%
Swimming	2.24%	.41%
Table tennis	.19%	.07%
Taekwondo	.18%	.46%
Tennis	4.10%	.96%
Triathlon	.05%	2.07%
Volleyball	1.54%	.41%
Water polo	No data	.00%
Weightlifting	.01%	.15%
Wrestling	No data	.00%

Table 4. Classification of sports according to the balance between youth memberships and success (ESI)

I - Low participation, high success	**II - High participation, high success**
Triathlon	Field hockey
Golf	Equestrian
Sailing	Cycling
Rugby sevens	Football
Skateboarding	Judo
Taekwondo	Tennis
Rowing	Athletics
	Basketball
	Gymnastics
	Swimming
	Volleyball
III - Low participation, low success	**IV - High participation, low success**
Canoe-kayak	
Archery	
Badminton	
Weightlifting	
Fencing	
Table tennis	
Karate	
Shooting	
Boxing	
Climbing	
Handball	

Figures