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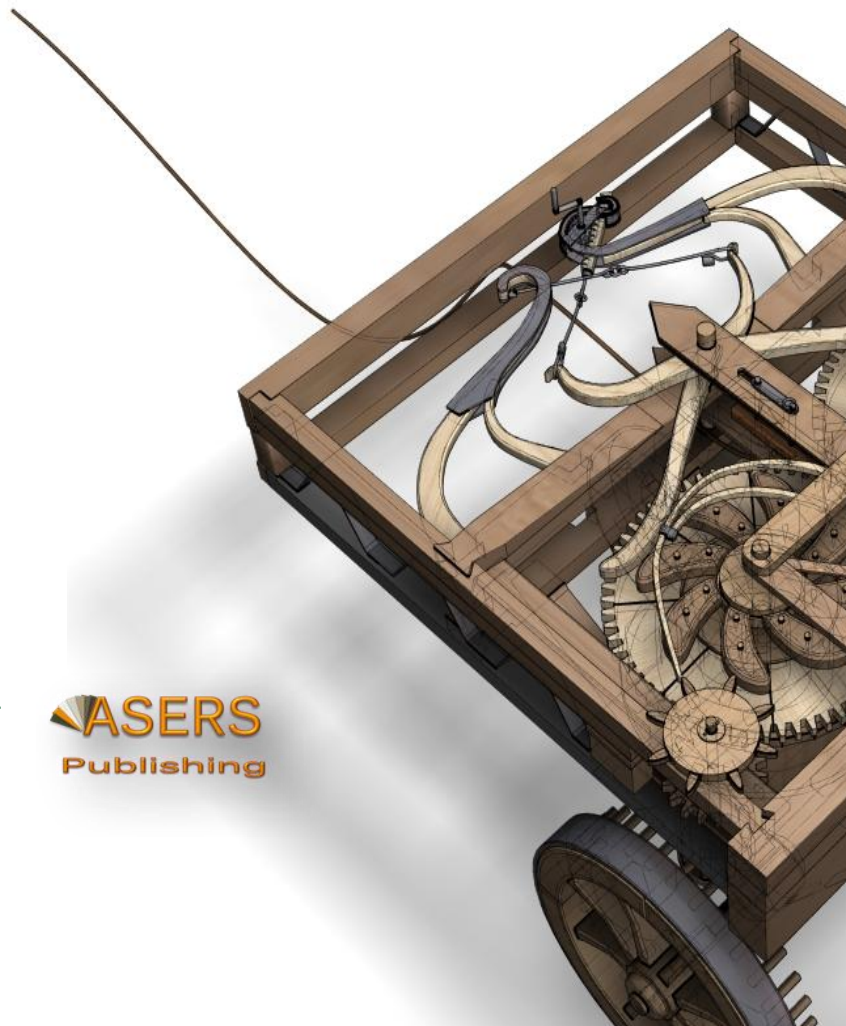
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Mental and Hedonistic Determinants Shaping Physical Activity Engagement among Generation Z

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Abstract: Consumers may exhibit various attitudes toward specific products, services, or activities. Regarding physical activity, a distinction can be made between a passive attitude, characterized by a lack of interest in sports and recreation, and an active attitude, manifested by participation in various forms of physical activity. This attitude is reflected in certain consumer behaviors in the sports market. The research question in this article is whether an interest in sports and recreation among Generation Z representatives translates into their actual physical activity. Additionally, moderating factors affecting this relationship, particularly the level of knowledge about sports and the availability of sports infrastructure and events, are analyzed. The purpose of the article is to identify and determine the impact of selected determinants that incline Generation Z representatives to engage in physical activity. The study was conducted using a survey method with the CAWI technique on a sample of 433 respondents representing Generation Z. Data were collected in the fourth quarter of 2024 in three metropolitan areas in Poland. The analysis of the results indicates that an interest in sports is a factor that encourages young people to engage in physical activity, which is strengthened by knowledge about sports. However, the availability of sports infrastructure and sporting events does not have a significant impact on the actual level of physical activity among Gen Z. In promoting sports participation among members of Generation Z, disseminating knowledge about physical activity is crucial. Shaping awareness and consumer attitudes proves to be more effective than merely increasing the availability of sports infrastructure or organizing sporting events.

Keywords: sports participation; physical activity; knowledge; consumer attitudes; Generation Z.

JEL Classification: L83; D12; I12; Z20.

Introduction

Generation Z as a social group is characterized by certain attitudes and consumer behavior, which in many cases differ significantly from those of representatives of other market segments (Kenebayeva, 2020; Wahyuningsih et al., 2022). This observation also applies to their approach to physical activity, which is one of the key forms of leisure time that impacts both physical and mental health. Modern technological conveniences, such as personal

transportation, streaming platforms, and mobile apps, widely used by Generation Z, may pose a significant threat to their regular physical activity (Roblek et al., 2019; Woessner et al., 2021).

In this article, considerations regarding the factors determining the engagement in physical activity by Generation Z representatives are undertaken. In the theoretical part, the discussion is based on the assumptions of the Stimulus-Organism-Response (S-O-R) theory, which posits that an individual's attitude or behavior (Organism) can change in the form of a reaction (Response) under the influence of external factors (Stimulus) (Mehrabian & Russell, 1974). This specific stimulus-response relationship can help explain the influence of certain determinants on young people's readiness to engage in sports and recreational activities. This theory was adopted as the theoretical basis for conducting empirical research, the results of which are presented in the later part of the article.

The primary research problem of this study is to determine whether the declared interest in sports and physical recreation by young people from Generation Z actually translates into their real engagement in physical activity. Knowledge about sports, considered a mental factor, and the availability of sports infrastructure and events, viewed as a hedonistic factor, were adopted as moderating determinants of this relationship. Therefore, the purpose of the article is to demonstrate whether there is a correlation between the interest in sports by Generation Z representatives and the actual undertaking of physical activity, as well as to determine the strength of influence of the mentioned determinants that may moderate this relationship.

1. Sports and Physical Activity Among Generation Z - A Literature Review

1.1. Challenges Associated with Physical Activity

Generation Z is referred to as those born between 1995 and early 2010 (Chaturvedi et al., 2020). This generation is also referred to as Generation C, digital natives, postmillennials and centennials. It is the first generation to grow up exclusively in the digital world and is fully immersed in digital communications (Axcell & Ellis, 2023). Understanding the behavior patterns of this generation is particularly important as it constitutes the largest generational group in the world (32% of the population), and its purchasing power is five to six times higher than that of previous generations (Djafarova & Fouts, 2022).

Generation Z has never experienced life without the internet. It is worth noting that growing up in a time of rapid technological development, however, comes with a number of civilization risks. First and foremost, social media and smart systems reduce the need to move and engage in activities outside the home (Roblek et al., 2019). Modern technologies decrease physical activity levels by eliminating the need for movement in areas such as transport, entertainment, and the digitization of work and education. Increasing use of private transport means (e.g. Uber, electric scooters) reduces spontaneous physical activity, including walking. Streaming platforms increase the number of hours spent sitting, and this lifestyle correlates with obesity and other civilizational diseases (Woessner et al., 2021). Furthermore, research indicates that the use of social media intensifies anxiety and dissatisfaction with one's appearance, leading to self-esteem issues, and prolonged screen use negatively affects sleep quality and mental health (Krumsvik, 2024). Although Generation Z declares an interest in a healthy lifestyle, their practical choices are not always consistent with these declarations. Growing health awareness often does not translate into undertaking real health-promoting actions (Agustina et al., 2024).

1.2. The Importance of Physical Activity

Numerous studies confirm that physical activity is an important determinant of health, with numerous social, psychological and physiological benefits. Regularly engaging in physical activity during leisure time translates into a higher quality of life (Peleias et al., 2017) and has a positive impact on the mental health of adults (Aguilar et al., 2022). In addition, a correlation can be observed between good grades among schoolchildren and the physical exercise undertaken (Snelling et al., 2015). Participation in extracurricular sports activities is associated with higher academic grades among higher education students (Muñoz-Bullón et al., 2017). It has also been confirmed that regular sports participation and volunteer activities have an indirect impact on reducing depressive symptoms in teenagers (Bang et al., 2020). Additionally, physically active young people are characterized by greater social resilience than those who do not engage in sports (Duman & Kuru, 2010). Recent longitudinal evidence shows that physical activity in early adolescence, particularly when practiced through organized sports, protects against the later onset of psychiatric disorders, underscoring its long-term role in safeguarding youth mental health (Lundgren et al., 2025). Moreover, employees who regularly engage in physical activity bring tangible benefits to the organizations they work for (Calderwood et al., 2016). A study conducted in Taiwan showed that female college graduates who participated in physical activities obtained higher initial salaries in the job market (Chiu, 2020).

Research conducted at Sheffield Hallam University on the social and economic impact of sports and physical activity showed that every pound invested in this area in England generates a socio-economic return of 4.20 pounds (Sport England, 2025). At the same time, lack of physical activity ranks fourth on the list of the most common causes of death worldwide (Williams-Burnett & Kearns, 2018). The World Health Organization (WHO) recommends that all adults engage in at least 150–300 minutes of moderate-intensity aerobic physical activity weekly to maintain health and well-being. Understanding the behavior patterns of young adults regarding active recreation and their perceptions of different ways of spending free time enables the implementation of effective strategies promoting an active lifestyle. As numerous studies confirm, this translates into improved physical and mental health and increases the overall quality of life.

On one hand, Generation Z representatives are particularly vulnerable to technology addiction and the negative health consequences of a sedentary lifestyle. On the other hand, this generation is characterized by a high awareness of the importance of health, physical activity, and proper nutrition in human life. They perceive sports as a tool serving health (Királová & Hamarneh, 2019). Such a paradox, makes the problem of Generation Z's engagement in physical activity a particularly interesting research area.

1.3. Determinants of Physical Activity

Physical activity is shaped by a broad range of factors that can either encourage participation in physical activity or serve as barriers to regular participation. It is influenced by both individual traits and external conditions in which individuals' function. Craggs et al. (2011) divided the determinants of physical activity into external and internal. Internal determinants included biological and psychological factors such as gender, age, self-esteem, sense of behavioral control, and motivation. External determinants, on the other hand, included socio-cultural and environmental factors, including family and peer support, availability of sports infrastructure, and neighborhood safety. In a similar study, McNeill et al. (2006) divided the determinants of physical activity into three groups: individual, social, and environmental. Individual factors included motivation (intrinsic and extrinsic) and self-efficacy, social factors concerned social support and peer pressure, while environmental factors included neighborhood quality and availability of infrastructure conducive to activity. The authors demonstrated that environmental factors, such as neighborhood quality and availability of sports facilities, have a direct impact on physical activity. Amireault et al. (2013) reached slightly different conclusions, showing that external factors, such as access to gyms or social support, are significant but do not determine long-term engagement in physical activity. Internal factors, especially self-efficacy and the intention to continue physical activity, are crucial. A study conducted in Mexico, Spain, and Saudi Arabia on motivational factors for physical activity showed that intrinsic motivation and identified regulation are the most important and universal drivers of engagement in exercise. At the same time, the findings highlight that cultural context should be considered when designing programs aimed at promoting physical activity (Prieto-González et al., 2025).

In this article, the authors divided the determinants of sports participation into:

- internal, where such constructs as interest in sports and knowledge about sports were considered;
- external, where such construct as available infrastructure and sports events were considered.

Interest in sports, taken as an attitude, refers to the degree to which an individual identifies with sports and physical activity as an essential part of their lifestyle. Individuals with a high level of interest in sports not only recognize physical activity as beneficial but also support initiatives related to its promotion and organization. This attitude is also manifested by actively following information about sports and a willingness to share knowledge and opinions about its health and social benefits. Thus, interest in sports also includes a cognitive and social aspect.

Knowledge about sports is a construct that encompasses awareness and understanding of the rules governing physical activity and its impact on health and body condition. It covers both general recommendations for the optimal amount of movement during the week and physiological mechanisms, such as the impact of physical activity on aging processes, mental health, or fat burning. This knowledge also includes the importance of regeneration in the training process and the individual's subjective belief that they have enough information to consciously make decisions regarding their healthy lifestyle and regular physical activity.

Available infrastructure and sports events are external factors that can significantly facilitate or hinder physical activity. It includes both the physical availability of sports and recreational facilities at the place of residence, their quality and functionality, as well as economic factors such as the cost of using sports infrastructure. Additionally, the presence of organized forms of physical activity in schools, universities, or workplaces, as well as the availability of spectator sports events, can be a motivating factor to engage in physical activity.

It is also worth mentioning that engaging in physical activity is defined by the authors as regularly participating in various forms of physical activity, both as part of planned workouts and daily choices that encourage greater activity. This includes the use of workout plans, either available online or developed by a personal trainer, as well as fitness apps and activity-tracking devices that support self-monitoring and motivation to move. Moreover, engaging in physical activity is reflected in conscious decisions to increase spontaneous physical activity, such as choosing stairs instead of an elevator or preferring active ways of spending free time, such as walking, cycling, or jogging. A key indicator of regular physical activity is also participating in sports or exercises at least three times a week, which indicates a consistent effort to maintain a healthy lifestyle.

In the conducted literature review, a research gap was identified concerning the limited number of publications dedicated to how Generation Z spends their leisure time actively. Understanding the behavior patterns of young consumers enables entities offering physical activity services to build a competitive advantage and also represents a social benefit. The aim of this article is to demonstrate whether there is a correlation between interest in sports and actual engagement in physical activity among Generation Z, as well as to determine the strength of the influence of the mentioned determinants that may moderate this relationship.

2. Stimulus-Organism-Response (S-O-R) Theory

The Stimulus-Organism-Response (S-O-R) theory, which originates from the basic stimulus-reaction schema, plays a crucial role in understanding how external stimuli affect human internal experiences, leading to specific reactions. Initially introduced by Mehrabian and Russell (1974) and later expanded by Jacoby (2002), this concept focuses on the mediatory role of human internal experiences, which mediate between stimuli and reactions (Arora, 1982).

According to the S-O-R theory, an external signal (Stimulus) can influence the internal state of an individual (Organism) and result in specific behavior (Response). S-O-R emphasizes that the environment, with its diverse attributes, acts as a stimulus (S), affecting the psychological states of individuals (O), which in turn influences their behaviors and attitudes (R) (Habachi et al., 2024). In this context, the Stimulus (S) is an external factor that leads to a change in the individual's internal state. The Organism (O) refers to the internal processes through which individuals transform stimuli into perceptions, emotions, or experiences, while the Response (R) is the individual's final actions in reaction to the Stimulus (Li et al., 2012). As a result, this leads to specific approaches or avoidance of certain attitudes or behaviors, considered as psychological responses (Fang et al., 2017).

Understanding the processes underlying the S-O-R theory allows for better analysis and prediction of human behavior in various contexts. To date, this theory has been used in studies on consumer behaviors addressing issues such as the impact of online reviews on purchase intention (Zhu et al., 2020), consumer attachment to smartwatches (Cho et al., 2019), user-generated content regarding travel intentions among Generation Z (Yamagishi et al., 2023), factors influencing the use of fitness apps (Teng & Bao, 2022), user participation in online health communities (Zhou et al., 2023), factors determining football fans' loyalty (Rahman et al., 2024), gamification, engagement, and loyalty among users of sports apps (Habachi et al., 2024).

Despite the relatively extensive literature utilizing the S-O-R theory in consumer behaviors, little attention is paid to the role of stimuli that encourage physical activity, especially in relation to Generation Z representatives. Therefore, it can be stated that there is a research gap in this field, which the authors of this article attempt to at least partially fill.

3. Theoretical Assumptions for the Research Model

In the most general terms, consumers towards sports and physical recreation can adopt two opposing attitudes: passive, meaning lack of interest, or active, meaning interest in this sphere of everyday life. Interest in sports may or may not lead to sports participation, so making such an assumption requires its empirical verification. Referring to the S-O-R theory on which the research model is built, a three-part construct was developed, where the Organism is recognized as interest in sports and physical recreation, the Response as actual participation in this physical activity, and the Stimulus consists of two moderating variables.

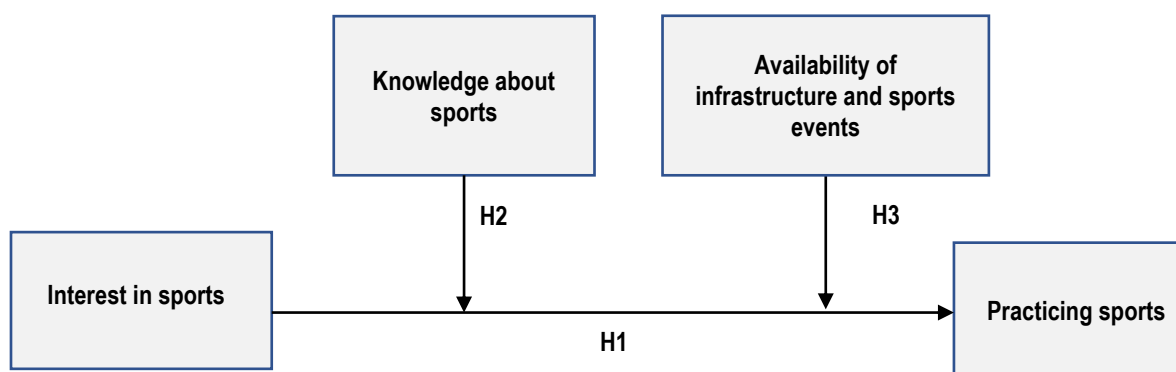
The first relates to the mental sphere of the consumer and is associated with their level of knowledge about sports and physical recreation. Knowledge shapes consumer awareness and can influence the attitudes they adopt towards specific objects or phenomena (Cheah & Phau, 2011). In this understanding, knowledge is considered an internal determinant that shapes consumer attitudes and behaviors in the market. In the field of social sciences, knowledge about sports has been the subject of scholarly discussion, among others, in the context of its informal acquisition through digital technologies (Ye & Zhang, 2024), the relationship between

coaches and athletes and their influence on the learning processes of students engaged in sports (Rey et al., 2022), and the connection between the knowledge possessed and the skills of football team players (Williams & Davids, 1995). The literature review conducted did not lead the authors of this article to publications where other researchers analyzed the relationship between knowledge about sports and physical recreation and consumer attitudes. Therefore, exploring the impact of the moderating variable of consumer knowledge about sports on the relationship between interest in sports and participation in sports is considered a new and unexplored area of research.

The second variable relates to hedonistic values, exemplified in the conducted studies by the availability of sports infrastructure and the opportunity to participate in sporting events. Both sports infrastructure and sporting events serve as an external determinant that can be a stimulus provoking specific attitudes and behaviors in consumers interested in physical activity. Atkinson et al. (2005) showed that the availability of appropriate sports infrastructure and an environment conducive to physical activity are positively correlated with residents' sports participation. In another study, a strong correlation was observed between the number of available swimming pools and participation in swimming classes, which may indicate that an increase in the number of swimming pools probably increases interest in this sports activity (Wicker et al., 2012). A friendly and properly arranged environment is a determinant factor for the level of physical activity among residents of a given destination. Many studies confirm that easy access to parks is associated with increased physical activity (Bedimo-Rung et al., 2005; Sallis et al., 2016; Kärmeniemi et al., 2018; Tcymbal et al., 2020). In the past, the poor quality of sports facilities was considered one of the reasons for the lack of interest in physical activity among consumers (Powell et al., 2006). Nowadays, as demonstrated by Clavel San Emetario et al. (2019), the quantitative and qualitative development of the fitness sector is considered one of the main factors successfully promoting behaviors related to physical activity in leisure time.

Factors that increase the accessibility of sports also include sporting events, both large-scale, where the consumption of sports manifests in watching the competitions of athletes (spectator sports), and those concerning amateur sports, such as running events, orienteering marches, or cycling competitions (participant sports) (Ramchandani et al., 2017; Lera-López et al., 2012). From the literature review, it is clear that despite numerous publications referring to the role of sports infrastructure or sporting events in promoting a healthy lifestyle, the impact of these factors on the strength of the relationship between interest in sports and participating in them has not been previously studied. As a result of the literature studies that were conducted, a research model was developed, which illustrates the relationships of interest to the authors of this article (Fig. 1).

Figure 1. Research Model



Source: Own elaboration.

Based on the presented model, the following three research hypotheses were proposed:

H1: Interest in sports has a positive impact on participating in sports;

H2: Knowledge about sports strengthens the relationship between interest in sports and participating in sports;

H3: The availability of sports infrastructure and events strengthens the relationship between interest in sports and participation in sports.

4. Method and Research Procedure

A survey was conducted using the CAWI technique to verify the proposed research hypotheses. The sample consisted of Generation Z representatives, i.e., individuals born between 1995 and 2010. A non-probabilistic

sampling method was used to reach the respondents, utilizing the selection of typical units. Data were collected in the fourth quarter of 2024 in three metropolitan areas: Tricity, Poznań, and Warsaw, with some respondents residing in these large agglomerations, while others came from smaller towns and localities. In the introduction to the questionnaire, respondents were informed about the purpose of the study and the authors conducting the research and were assured of anonymity and voluntariness in providing responses.

A total of 432 correctly completed questionnaires were collected. Among the participants, 40% rated their physical activity as high or very high, 47% as moderate, and only 17% as low or very low. Nearly 75% of the respondents stated that taking care of their health is an important or very important priority for them, which may indicate their relatively high level of health awareness.

In examining the previously defined constructs, four original indicators were used for each. This decision was made because a review of the literature did not lead the authors to identify indicators that would be useful in this study. For this purpose, the authors, who have many years of research experience in the sports market, utilized their specialized knowledge and experience. Items for all constructs were measured on a five-point Likert scale (where 1 meant "strongly disagree" and 5 "strongly agree").

Interest in sports was measured using four items (e.g., "I keep up-to-date with information about sports and physical activity"), with a Cronbach's alpha of 0.679. The availability of infrastructure and events was examined through four items, for example, "At my school, university, or workplace, there is an opportunity to engage in organized forms of physical activity" (Cronbach's alpha = 0.680). The remaining two constructs were formative. Participation in sports was measured using four items (e.g., "I engage in sports or physical activity at least three times a week") with a low level of correlation between items ranging from 0.154 to 0.307. Knowledge about sports was measured using four items, for example, "Long (at least 30 minutes) and moderate physical effort is more conducive to burning fat than intense, short exercises." The correlation between items was low and ranged from 0.055 to 0.243.

The study utilized Hayes' double moderation model (model 2). A bootstrapping procedure with 5,000 resamples was applied. Data analysis was performed using the PROCESS algorithm (ver. 4.2) as an add-on to SPSS (ver. 29). Before proceeding with the analysis, variables were centered to reduce multicollinearity, which is a recommended action in the context of moderation research.

5. Research Results

To test the hypothesized moderating effects of two constructs, namely knowledge about sports and the availability of sports infrastructure and events on the relationship between the other two constructs, i.e., interest in sports and participation in sports, an analysis was conducted using Hayes' PROCESS algorithm (Model 2). The results indicate that the model as a whole is statistically significant $F(5, 424) = 37.77, p < 0.001$ and explains 30.82% of the variance in the dependent variable (participation in sports). In the field of social sciences, such a result is considered satisfactory (Ozili, 2023). Predictor variables, i.e., interest in sports, knowledge about sports, availability of infrastructure and sports events, and their interactions, explain a significant portion of the variability in the level of sports participation.

The results concerning the main effects are presented in Table 1. They indicate a strong, positive relationship between interest in sports and participation in sports ($B = 0.6316, p < 0.001$). Of the other two predictors, a direct significant effect was observed for knowledge about sports ($B = 0.2126, p = 0.0102$), while no significant direct impact of the availability of infrastructure and sports events on sports participation was observed ($B = -0.0239, p = 0.6191$), where the confidence interval includes the value 0.

Table 1. Moderation Analysis Results (Main Effects)

Variable	B (Coefficient)	SE (Standard Error)	t	p	Lower Interval (LLCI)	Upper Interval (ULCI)
Constant	-0.0287	0.0373	-0.7701	0.4416	-0.1019	0.0445
Interest in sports	0.6316	0.0520	12.1482	<0.001	0.5294	0.7338
Knowledge about sports	0.2126	0.0824	2.5792	0.0102	0.0506	0.3747
Availability of infrastructure and events	-0.0239	0.0480	-0.4975	0.6191	-0.1182	0.0705
Constant	-0.0287	0.0373	-0.7701	0.4416	-0.1019	0.0445

Source: Own elaboration based on empirical research.

The effects of the interaction between the two moderating variables are presented in Table 2. The results indicate that the interaction between knowledge about sports and the relationship between interest in sports and participating in sports is statistically significant ($B = 0.3038$, $p = 0.0042$). Such results mean that the influence of interest in sports on participating in sports increases as knowledge about sports increases.

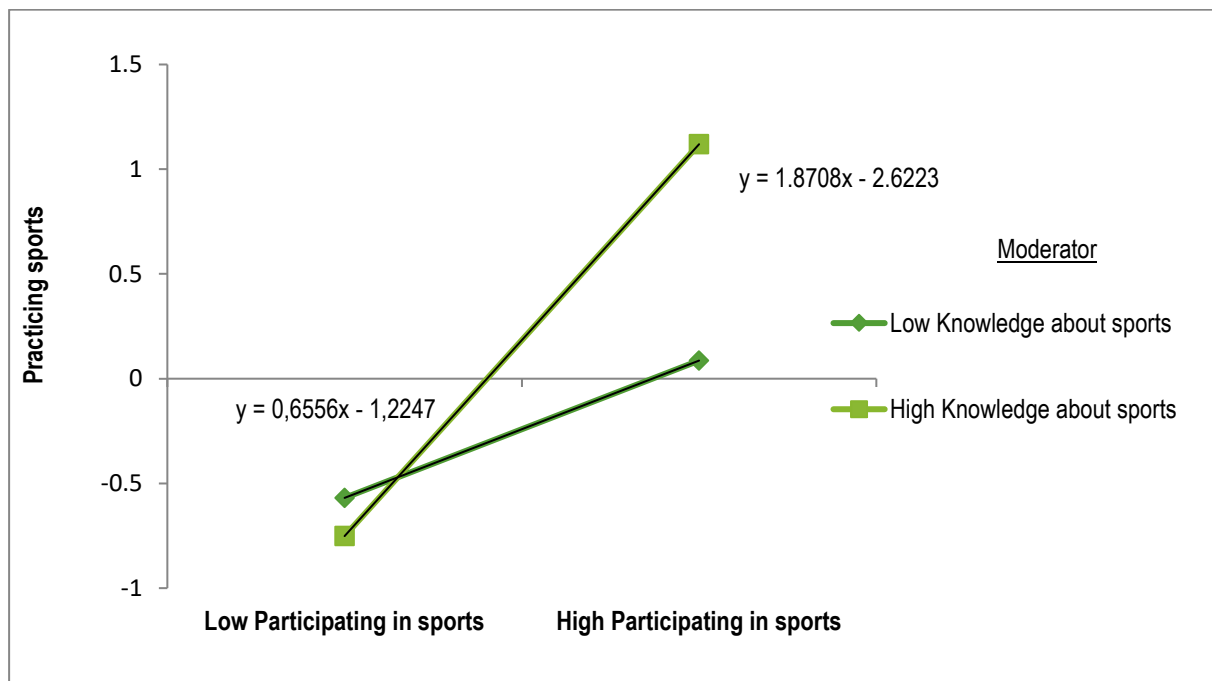
Table 2. Moderation Analysis Results (Interaction Effects)

Interaction	B (Coefficient)	SE (Standard Error)	t	p	Lower Interval (LLCI)	Upper Interval (ULCI)
Interest in Sports × Knowledge about Sports	0.3038	0.1056	2.8782	0.0042	0.0963	0.5113
Interest in Sports × Availability of Infrastructure and Events	0.0032	0.0639	0.0493	0.9607	-0.1225	0.1288

Source: Own elaboration based on empirical research.

To better illustrate the observed interaction, its results are presented graphically in Figure 2. Although interest in sports translates into a higher level of sports participation among both individuals with low and high levels of knowledge, the relationship is stronger among those with higher knowledge. This is illustrated by the shallower slope of the line for the group with lower knowledge levels, as shown in Figure 2.

Figure 2. Moderating Effect of Sports Knowledge



Source: Own elaboration based on empirical research.

The increase in explained variance due to the observed interaction is statistically significant $\Delta R^2 = 0.0135$, $p = 0.0042$, although it is relatively small, accounting for 1.35% of the explained variance.

The second moderating variable, i.e., the availability of sports infrastructure and events, did not have a significant impact on the strength of the relationship between interest in sports and participation in sports ($B = 0.0032$, $p = 0.9607$). This means that regardless of the perceived availability of infrastructure and sports events, the relationship between interest in sports and participation in sports remains unchanged.

6. Discussions and Limitations

The study indicates that efforts to promote sports and physical activity among Generation Z should primarily focus on increasing their knowledge about sports, i.e., target the mental sphere. It appears that providing this consumer segment with access to modern sports infrastructure and events that appeal to hedonistic values is less effective in shaping habits of sports participation and recreation. This conclusion somewhat weakens previous findings of other studies that have shown a positive correlation between the availability of sports infrastructure and the

physical activity of various consumer groups. The study conducted by the authors sheds new light on the conditions shaping the relationship between interest in sports and its practice. Previously, stimuli of a hedonistic nature, providing pleasure, joy, and opportunities for distinction and expression, were considered leading in the process of shaping consumer attitudes and behaviors in the sports market. However, the significance of the mental sphere of consumers seems to have been overlooked or marginalized, although it may play a much larger role than previously thought.

The authors of the article are aware of the limitations of the study, both in terms of its exploratory and cognitive nature. Primarily, although the study was conducted on a relatively large sample of respondents, they were only selected from a few chosen locations. It is important to remember that the respondents' answers were subjective, and issues such as the level of knowledge or access to infrastructure and sports events could have been assessed realistically or perceived individually. The type of physical activity practiced by respondents could also have influenced their responses. Some sports activities, such as running, Nordic walking, or cycling, do not require as extensive infrastructure as swimming, sport shooting, or climbing.

Generation Z representatives, although they represent a strictly defined, generally accepted age group, still constitute a heterogeneous community. To gain greater certainty in the conclusions drawn from the study results, they should be confronted with the demographic or psychographic characteristics of this generation. The relationships examined in this study also take the form of feedback. Longitudinal studies, including Granger causality tests or experimental research, would be useful in checking this direction of influence.

Conclusions and Further Research

The research findings make a significant contribution to the current state of knowledge on the determinants that motivate young people to participate in sports and physical activity. In particular, the results demonstrate that knowledge plays a crucial role in shaping physical activity among Generation Z members, even more so than factors such as the availability of sports facilities. This highlights a novel perspective on how to effectively encourage this generation to participate in sports.

Although it is commonly believed that Generation Z members are often driven by hedonistic impulses and seek values associated with pleasure, conspicuous consumption, and self-expression, the conducted research has shown that at least in some areas this is not the case. Factors located in the mental sphere, such as the knowledge analyzed, more than those related to convenience or the availability of facilities or sports events, incline them to an active lifestyle based on sports and physical recreation. The results of the presented studies do not undermine or diminish the role of sports infrastructure, which has been repeatedly emphasized in scientific publications as a determinant of interest in physical activity, but they highlight the importance of knowledge, which until now has not been the subject of research in this area and was not associated with greater motivation to engage in sports activities. This discovery not only has cognitive value that may contribute to further, in-depth research but also practical value. It turns out that institutions responsible for the development of physical culture and sports, both at the central and local levels, in addition to investing in sports infrastructure or subsidizing sports events, should pay more attention to information policy and shaping knowledge about sports among Generation Z.

Credit Authorship Contribution Statement

Zygmunt Waśkowski: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing – original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization

Liwia Delińska: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing – original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization

Tomasz Wanat: Methodology, Software, Formal analysis, Writing – original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have used generative AI in the writing process before submission, but only to improve the language and readability of the paper and with the appropriate disclosure.

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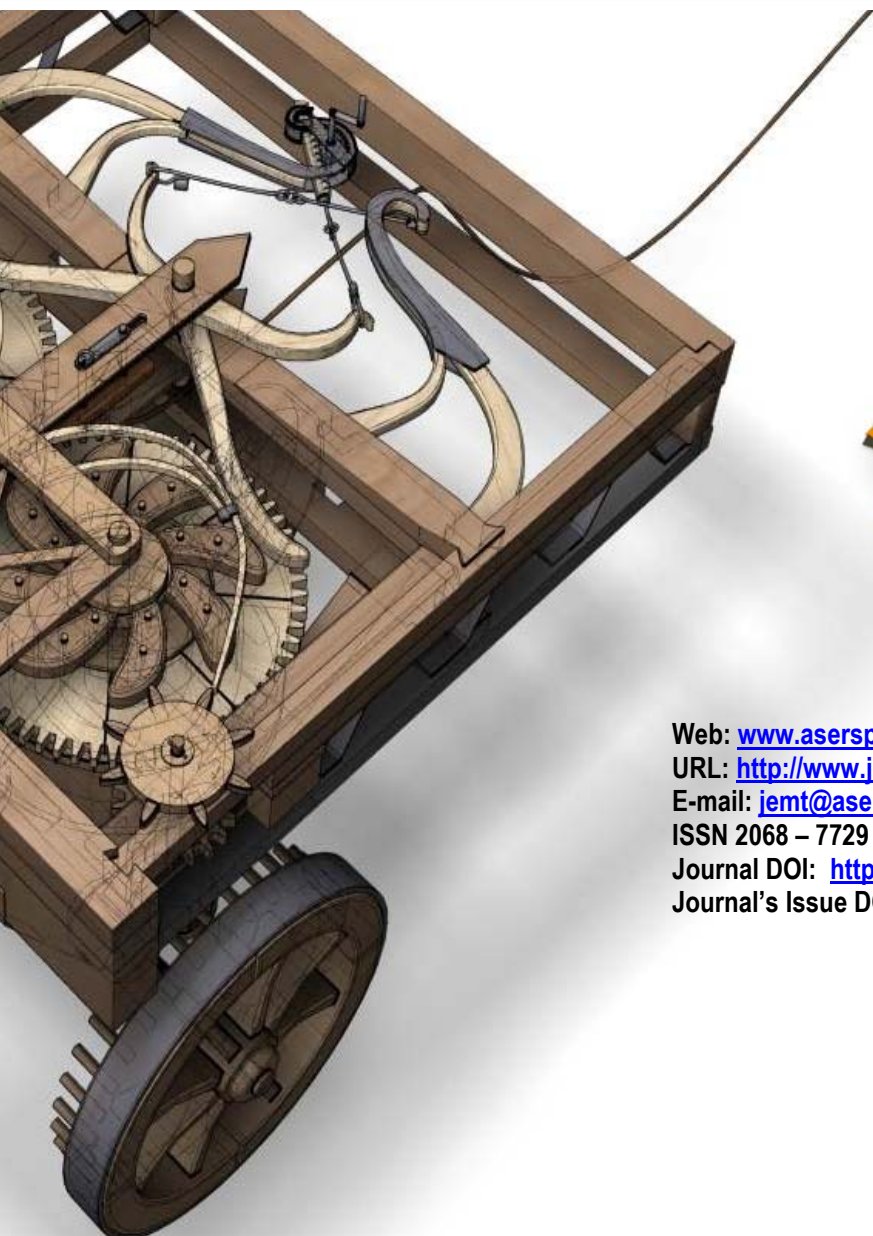
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