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Understanding the importance of sport infrastructure for participation in different sports – findings from multi-level modeling

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Previous research has shown that participation in different sports can be predicted using a socioeconomic model. However, the importance of sport infrastructure for sport participation in different sports has been mostly ignored. The purpose of this paper is to examine the influence of various types of sport facilities on participation in different sports. Using multi-level analyses, an assortment of sport participation surveys with an overall sample size of $n=9302$, combined with data concerning the municipalities’ sport infrastructure are used to test for the effect of infrastructure on sport participation. The results imply that different sports are impacted by different indicators, and that substitution effects could occur. The findings suggest, for example, that municipalities that are aware of the limited supply of swimming pools should promote sport participation in running, through emphasizing the sport opportunities available in parks.

**Keywords:** hierarchical model; sport activity; sport facilities; substitution effect; physical activity

**Introduction**

One peculiarity of sport is that it not only contributes to satisfying individual needs such as individual fitness, fun, and well-being, but also produces external effects like social integration, socialization, democracy, and public health (Heinemann, 2005). It is therefore in the interest of governments to foster sport participation. Several governments (e.g. England, Scotland, and The Netherlands) have a health agenda that postulates the importance of being physically active and publish recommendations for weekly sport participation. Yet, adequate sport infrastructure is important to sport participation, as many sports cannot be performed without having the appropriate sport facility. According to Xiong (2007), the Chinese Government identified the purpose of sport infrastructure’s role in the nation’s fitness level and implemented a nationwide policy in 1995 to improve spending on sport in China. Whereas elite sport had been the main focus in China since 1960 (Hong, 2008), the aim of this new policy was to increase sport participation among the wider population. A large portion of the money raised for China’s *National Fitness Program* was then spent on building sport facilities, especially in the urban areas. As
a result of this program, Chinese mass sport participation grew substantially during the last decade (Xiong, 2007), which indicates the relationship between participation and infrastructure. To sum it up, adequate sport infrastructure is needed to succeed in the government policy objective of fostering sport participation.

What constitutes adequate sport infrastructure differs from sport to sport: different sports have different requirements for the given facility. Obvious examples might be that a pool (or open water) is needed for swimming and a prepared court is required for tennis. Thus, the availability of facilities has an influence on the chosen sport. Space, for example for parks, is also a consideration which challenges municipalities with regard to urban planning. For policy makers it is important to know which types of sport infrastructure should be built to increase sport participation.

Therefore, the purpose of this study is to determine the importance of sport infrastructure for participation in different sports. In detail, the aim of this research is to examine the importance of different types of sport infrastructure for participation in four specific sports, namely swimming, running, soccer, and tennis. These sports were chosen as they require different types of sport infrastructure. From a functional point of view, sport infrastructure enables community members to participate in sport. In the current study, sport infrastructure can be defined as the primary physical and organizational construction needed to facilitate sport participation. Here, the term sport infrastructure also relates to the availability and type of sport facilities within a community (e.g. a park or recreation center used for sport purposes).

The structure of this contribution is as follows. First, the current state of literature regarding sport participation and sport infrastructure’s general influence on communities and general sport participation is summarized. In particular, the current state of research on the interplay between infrastructure and sport participation is discussed. Second, the theoretical model is described, followed by an explanation of the methods used for the research conducted. It is shown that multi-level modeling is the appropriate method to use for this kind of study where variables from two hierarchical levels (individual and infrastructure level) are used to explain sport participation in different sports. Then, the results are presented and discussed along with the limitations of the study before concluding with policy recommendations.

This research endeavor is relevant from a theoretical, methodological, and practical standpoint. Theoretically, this paper aims to contribute to the growing body of literature on the relationship between sport participation and infrastructure. From a methodological standpoint, the impact of infrastructure and individual determinants on sport participation are shown using multi-level modeling. This method is rather new in sport management research, as will be shown in the Literature Review and Methods sections. From a practical perspective, this research helps sport managers and policy makers to identify key drivers of participation in different sports which could enable them to plan the construction of facilities more profoundly.

**Literature review**

**Individual determinants of sport participation in general and in different sports**

General sport participation and physical activity can be explained from an integrated socioeconomic perspective (e.g. Downward, Dawson, & Dejonghe, 2009). Previous research has investigated the importance of different variables on sport participation
(e.g. Berger, O’Reilly, Parent, Séguin, & Hernandez, 2008; Downward & Riordan, 2007; Farrell & Shields, 2002; Lera-López & Rapún-Garate, 2007; Ruseski, Humphreys, Hallmann, & Breuer, 2011; Stamm & Lamprecht, 2005; Stratton, Conn, Liaw, & Conolly, 2005; Taks, Renson, & Vanreusel, 1994). With regard to sociodemographic determinants, gender, age, and nationality/ethnic background have been identified as influencing factors (e.g. Lera-López & Rapún-Garate, 2007; Ruseski et al., 2011; Stamm & Lamprecht, 2005; Stratton et al., 2005). Furthermore, income, time, and human capital (i.e. level of education) have been acknowledged as economic determinants (e.g. Becker, 1996; Breuer, 2006; Farrell & Shields, 2002; Frey, 1999).

In addition, some research has been conducted on the determinants of participation in different sports (Downward, 2004; Seabra, Mendonca, Thomis, Malina, & Maia, 2007). There are many disparities and the influence of the determinants varies among different sports (Downward, 2004). In general, it has been found that there are gender differences with regard to sport activity (Humphreys & Ruseski, 2007; Ifedi, 2008). For example, males typically participate in sports like ice hockey, golf, basketball, baseball, and soccer, whereas females tend to take part in swimming, golf, soccer, volleyball, and skiing (Ifedi, 2008). In addition, males are more likely to participate in both team and individual sports while females participate more in walking and household activities (Humphreys & Ruseski, 2007). Downward (2004) found that being female and of young age, as well as being affluent, fosters swimming participation, while being male and of young age promotes participation in soccer and running. Moreover, being affluent is a further determinant of running participation.

**Interrelationships of sport participation and infrastructure**

Interrelationships between taking part in sports and sport infrastructure have been the core of some studies, with focal points such as general sport participation (e.g. Cerin & Leslie, 2008; Wicker, Breuer, & Pawlowski, 2009), participation in particular sports (e.g. Eyler, Brownson, Bacak, & Housemann, 2003; Owen, Humpel, Leslie, Bauman, & Sallis, 2004), government policy (Xiong, 2007), and quality management/service quality (e.g. Liu, Taylor, & Shibli, 2009; Robinson, 1999). The results of previous studies with regard to possible interrelationships between sport participation and infrastructure are mixed. For instance, in one study it was found that pathways close to the home had a positive impact on sport participation (Eyler et al., 2003), while in a different study no impact was reported (Giles-Corti & Donovan, 2002). In a meta-analysis of selected studies on physical activity and the perceived environment, evidence was found for a positive effect of sport infrastructure, sidewalks, shops, and services in walking distance on taking part in sports (Duncan, Spence, & Mummery, 2005). Yet, the authors of that particular study highlight the small sample they used due to the heterogeneous measurement of physical activity. It has to be added that this applies as well to infrastructure (e.g. Owen et al., 2004), which can be measured subjectively (as perceived by the respondents) or objectively (as in numbers or area available).

Moreover, a case study based on interviews and focus groups reported that Muslim women have a difficult time participating in sports due to a lack of women-only facilities (Maxwell & Taylor, 2010). Their need for this specific infrastructure is
determined by their religion (Amara & Henry, 2010). As both Amara and Henry (2010) and Maxwell and Taylor (2010) followed an exploratory approach, no objective measures of infrastructure were included. Instead, perceived infrastructure or perceived constraints to sport participation were addressed. This issue is also of note in the meta-analysis of Duncan et al. (2005) who only integrated studies that used the perceived environment (infrastructure) instead of studies that used objective measures of infrastructure as the latter are scarce. Thus, this study will use objective measures of infrastructure.

Diverse sports have different requirements regarding the time needed for participation as well as travel to and from the facility (e.g. Pawlowski, Breuer, Wicker, & Poupaux, 2009), which is ultimately affected by the facility’s location. As a result of the various time and monetary needs for different sports, it has been found that the price of time differs significantly from sport to sport as a result of both the sport itself and of differing income levels (Taks et al., 1994). In a UK study, an underrepresentation of the lowest socioeconomic groups and people of 60 years and older in the use of public sector facilities was observed (Liu et al., 2009). This result implies that income and age serve as restrictions for the usage of public sport facilities in this context. The delivery system of the sport (e.g. provided in school, through local non-profit sport clubs, private clubs, or the landscape) also plays a major role for taking part in sport (Lim et al., 2011). This applies also to parent’s involvement with sport.

In addition, it has been found that ‘areas with higher household income (are) perceived as having better access to individual sports facilities, higher levels of aesthetics, fewer physical barriers to walking, and lower levels of crime and traffic, but, also, poorer access to public open space and team-sports facilities’ (Cerin & Leslie, 2008, p. 2605). This leads to the conclusion that sport infrastructure is of importance for participation in different sports.

**Determinants of sport participation based on the supply of infrastructure**

Insufficient infrastructure can restrict sport participation (Atkinson, Sallis, Saelens, Cain, & Black, 2005; Lim et al., 2011). To phrase it positively, a good supply of sport infrastructure fosters sport participation (Chad et al., 2005; Haug, Torsheim, Sallis, & Samdal, 2008; Limstrand & Reher, 2008). Specific advances in the literature are provided by the studies conducted by Ewing, Schmid, Killingsworth, Zlot, and Raudenbush (2003), Haug et al. (2008), and Wicker et al. (2009), as they used a multi-level perspective, taking the differences between individual and place characteristics into account. This perspective is valuable as it considers individual decisions (taking part in sport or not) and sets these decisions into a context (Lim et al., 2011), in this case the availability of sport infrastructure. Thereby, the dependence of the respondents and the given place is included (Ewing et al., 2003). With regard to general sport participation, and taking the multi-level perspective into consideration, it has been found that the availability of sport infrastructure has significant relationship with the sport activity patterns of different age groups (Wicker et al., 2009). A poor supply of swimming pools in the urban district of the residents was found to correlate negatively with the sport participation of younger people (from 3 to 18 years) and the older age group (over 65 years). In contrast, the availability of sport fields, gymnasium, and fitness centers was important to the sport
participation of people from 19 to 28 years. Previous research has also shown that the county sprawl has a significant and positive relationship with the duration of walking activity (Ewing et al., 2003). The number of outdoor facilities at schools had a positive relationship with boys and girls being physically active. Moreover, it was found that the perceived availability of areas for hopscotch/skipping rope, soccer fields, and sledging hills increased the odds of boys taking part in sports (Haug et al., 2008).

Very little research has been conducted on sport infrastructure concerning different sports. Nevertheless, some studies have included sport infrastructure in their investigations of participation in different sports. For instance, it has been shown that swimming participation is associated with the availability of swimming pools (Shibli, 2009), and walking can be increased through existing pathways in close proximity to home (Eyler et al., 2003). Several environmental characteristics such as coastal location (Humpel, Owen, Iverson, Leslie, & Bauman, 2004) or access to beaches (Giles-Corti & Donovan, 2002) have a positive relationship with taking part in walking (for an overview see Owen et al., 2004). However, in those studies only subjective measures of infrastructure (Humpel et al., 2004) or a one-level approach (Giles-Corti & Donovan, 2002) were used. Wicker et al. (2009) used objective measures for sport infrastructure. In their study, the available sport infrastructure in every urban district of the city of Stuttgart was counted and urban districts with poor and good supplies of sport infrastructure were identified.

Summing up, a lack of research with regard to the significance of sport infrastructure for sport participation, especially concerning that of different sports using objective measures for infrastructure and undertaken from a multi-level perspective can be identified. Consequently, more research is needed to investigate the significance of sport infrastructure for sport participation, particularly with regard to different sports.

**Theoretical framework**

The theoretical model consists of factors from two levels: Individual socioeconomic factors and infrastructure factors. With regard to socioeconomic factors, time, income, and human capital are individual-level factors, which arise from the economic household theory (Downward, 2007). The socioeconomic perspective of the model is expanded with various factors such as age, nationality, and gender (Breuer, 2006). With regard to the infrastructure level, several types of sport facilities have to be taken into consideration. These facilities include sport halls, sport fields, swimming pools, parks, and tennis courts. The factors of the theoretical model and the underlying theoretical framework are explained in more detail below.

On the individual level, a socioeconomic model based on the economic theory of behavior (Becker, 1993, 1996; Frey, 1999) is used which has been applied in previous research on sport participation (e.g. Downward, 2007; Downward & Riordan, 2007; Humphreys & Ruseski, 2010; Wicker et al., 2009). The theoretical implications of this model have been extensively explained by Downward and Rasciute (2010). According to Becker’s (1965) theory, participation needs to be produced by a person through allocating market commodities, such as time and equipment, to a sporting activity. According to Becker (1974), distinct characteristics of an individual, or other individuals, can affect this production process (e.g. human capital). Thus,
individuals can allocate market goods and time to invest in the “production” and then consumption of sport directly, or to the acquisition of personal consumption capital, or social capital that then underpins sports participation’ (Downward & Rasciute, 2010, p. 197). In line with this theory, the decision to take part in sports is dependent on several restrictions such as pecuniary and temporal limitations (Humphreys & Ruseski, 2010). The idea of restrictions can be transferred to the infrastructure level as the availability of sport infrastructure can also represent a restriction to an individual’s sport participation, particularly for some sports that require specific sport facilities. To provide an example, it is difficult to participate in tennis if no tennis court is available. This fact leads to the assumption that participation in different sports is correlated with the availability of specific sport infrastructure.

First, money and time restrict the opportunities for an individual to participate in sport. Therefore, it can be assumed that individuals with a lower income abstain from participating in sports that are typically seen as reasonably expensive or for those with a high income, e.g. tennis (Taks et al., 1994). The availability of time and income can play a role in an individual’s decision of whether or not to and how to participate in sport. On the one hand, those with a low income may opt to use their leisure time for inexpensive activities such as running. On the other hand, individuals with a higher income may value their time differently and choose rather to take part in sporting activities that require little time like personal training or private tennis lessons (Downward, 2007). For those who work long hours, sports such as tennis may pose a problem due to the restricted opening hours of outdoor courts. They may prefer activities such as running that can be practiced regardless of time (and place). Furthermore, tennis is a rather expensive sport to participate in (i.e. membership fees, equipment), whereas running is not, which leads to the assumption that income might be a restriction of taking part in tennis.

In addition to income and time, human capital is also an important factor which influences an individual’s sport participation decisions (Humphreys & Ruseski, 2010). Human capital, which relates to an individual’s educational level, indirectly affects an individual’s time and income. In addition, through long-term physical education, a higher sport proficiency is acquired which expands the opportunities for sport participation within the limits of monetary and time restrictions. It is suggested that a higher educational level goes along with higher knowledge about how to play a sport, fostering the productivity of time and goods used for physical activity (see also Breuer, 2006).

In this model, sport participation is also subject to further socioeconomic variables which expand the household theory – specifically age, gender, and nationality. These factors can also pose further restrictions to sport participation. With regard to age, physical abilities and health typically decline with age, which can represent limitations to an individual’s ability to take part in sporting activities. For example, average-aged adults characteristically participate in sports such as running, whereas older adults take part in lower impact sports such as walking or swimming. Furthermore, an individual’s gender plays an important role in determining the type of sport participation. For example, restrictions to female sport participation can occur at the individual, structural, and cultural levels (Doherty & Varpalotai, 2001). This means that individuals that originate from a different culture because of, for example, migration may face a restriction on the acceptability of participation in
sports generally, or some sports specifically. In addition, the way in which men and women socially value sport participation may differ greatly, in particular in the realm of specific ethnic or religious groups. For instance, it is generally considered by the Muslim culture as less attractive for women to participate in sport (Maxwell & Taylor, 2010). Thus, nationality may affect one’s sport participation patterns. In this framework, it is suggested that those with a migration background typically participate in team sports such as soccer, rather than individual sports like swimming or running. This is the case as team sports are often offered by non-profit sport clubs which consider offering sports for people with migration background as part of their philosophy (Breuer & Wicker, 2011) and can thus foster social inclusion.

At the infrastructure level, it is suggested that several types of sport infrastructure are important determinants of participation in different sports. In the current study, swimming pools, sport halls, sport fields, tennis courts, and parks in the suburb of the residents are relevant. With regard to sport facilities, the availability of space is paramount for sport-related activities (Büch, 2005; Heinemann, 1998). In addition, the location of these facilities may have a significant influence on an individual’s participation as, for instance, the probability of spending additional time in traveling to the facility decreases with an increase in the actual time an individual needs to reach the facility (Pawlowski et al., 2009). These findings suggest that the proximity of sport facilities is important. Therefore, it is assumed that the presence of facilities in the suburb of the residents is positively associated with participation in the respective sport. Accordingly, the number of swimming pools in the suburb should be positively correlated with swimming participation, the number of sport halls and fields should be positively linked to soccer participation, the number of tennis courts should positively correlate with tennis participation, and the park area in the suburb should be positively associated with running participation.

Methods

Data sources

Sport participation surveys were conducted in four municipalities in Germany from December 2008 to May 2009. Three medium-sized towns situated in the state of North Rhine Westphalia were investigated: Bergheim (62,011 inhabitants; survey took place in May 2009), Pulheim (53,469 inhabitants; survey was conducted in December 2008), and Würselen (37,784 inhabitants; survey took place in February 2009). In addition, the region of Waldeck–Frankenberg, located in the state of Hesse and consisted of 22 small towns and communities (166,053 inhabitants; survey was conducted in February 2009), was included.

The inhabitants of the different municipalities were questioned by means of a computer-assisted telephone interview (CATI) to collect the data on the individual level. In order to guarantee a representative sample, three quality measures were introduced. First, the selection of the sample was carried out using the Gabler–Häder approach to also include people who cannot be found in the telephone book (Gabler & Häder, 1999). This means that the potential order of digits of a telephone number was generated by the computer instead of using the telephone book in which only people who apply for being listed are mentioned. Thus, a representative sample can be guaranteed as everyone having a telephone in the respective municipality had
a chance to get into the sample. Second, the last-birthday method was used as another quality measure. In some households, the same person always answers the phone, so this procedure was chosen to guarantee that not the person picking up the phone is always questioned. As a third quality measure, every household was called up to 10 times until a responder was contacted as different people have different times when they are at home. A total of \( n = 7043 \) interviews were carried out in the four municipalities. The total number includes \( n = 1507 \) respondents in Bergheim (response rate: 51.6%), \( n = 2006 \) in Pulheim (response rate: 55.2%), \( n = 1514 \) in Würselen (response rate: 49.6%), and \( n = 2007 \) in Waldeck–Frankenberg (response rate: 51.6%). Questions about the sport participation of children aged 3–17 years were answered by their parents and were included in the overall sample which comprised \( n = 9302 \) interviews. All sub-samples were representative of the respective municipality with regard to age, gender, nationality, and suburb. It has to be noted that the data are cross-sectional as respondents were only surveyed once.

The questionnaire developed was similar for all surveys and contained questions about sport participation such as ‘Do you practice sport in your free-time?’ If this question yielded a positive answer, respondents were then asked about the sports they participated in most frequently and next most frequently: ‘Which sports do you practice most/second most often?’; and thereafter ‘How many times in general do you practice this sport per week?’ These questions were re-coded into dummy variables for each sport. For instance, if the answer for the question about the first and second most often practiced sport yielded the answer ‘sports swimming,’ and the question about the frequency of practicing yielded ‘at least once per week’, the dummy was coded with \( I = \text{yes} \) for swimming participation (see Table 1). Moreover, the respondents were asked to indicate their socioeconomic characteristics such as age, gender, and nationality. Information relating to the respondent’s education, income, working time, and time for childcare and care for relatives was also requested. The questions for age, income, working time, and time for childcare and care for relatives were open-ended. Gender was indicated by the interviewer based on the name of the interviewee (if the interviewer was not sure then the interviewee was queried). The question for human capital asked ‘What is the last educational level you attained?’ and had seven categories of selection referring to the German educational system. This variable was thereafter recoded into a dummy variable indicating \( I = \text{yes} \) for people having at least A-levels (university entrance diploma). The nationality was asked for in various categories (German, double-citizenship of German and a second nationality, foreign nationality). All items presented in this paper were worded identically in all questionnaires for all four municipalities. An overview of the operationalization of all variables is presented in Table 1.

In addition to the individual level, data were also collected at the infrastructure level. The municipalities, or more precisely their department responsible for sport facilities, provided secondary data about the supply of their sport facilities. This information included the number and area of sport facilities per suburb of the respective municipality. This means that the sport infrastructure in every suburb was counted and arranged in a table. The suburb was used as the unit of analysis as it represents the municipalities’ unit of city planning. In total, the overall data-set includes 53 suburbs which are distributed as follows: Bergheim (15 suburbs), Pulheim (12 suburbs), Würselen (4 suburbs), and the region of Waldeck–Frankenberg (22 suburbs). It has to be noted that both common (e.g. sport halls, sport fields,
swimming pools, and tennis courts) and uncommon (e.g. park areas) sport infrastructure were included in the secondary data collection. The sport infrastructure of each suburb was divided by the number of inhabitants of the suburbs to control for the different sizes of the suburbs (criterion: number of inhabitants). For instance, in Waldeck–Frankenberg the number of inhabitants ranges from 1925 to 24,188 per suburb.

Data analysis

Each sport was modeled separately using a multi-level approach, where each model’s dependent variable was one of the sports. The individual and infrastructure factors are the same for each of the four models, with only the dependent variable changing. The first model estimates the influence of socioeconomic indicators and infrastructure on running; the second tests the impact of the same variables on swimming; the third model analyzes the same indicators’ influence on soccer; and the fourth model on tennis.

Multi-level analyses are performed using the HLM 6.02 software. The multi-level approach is employed as it is the appropriate method for research designs where the data are organized on more than one level (Tabachnick & Fidell, 2007). Multi-level analyses are chosen because conventional regression analyses do not take the hierarchical structure of the data into consideration. This might lead to false interpretations of the outcome (Moulton, 1990) such as ascribing effects that occur

<table>
<thead>
<tr>
<th>Variable</th>
<th>Operationalization</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td>Weekly participation in swimming (1 = yes)</td>
<td>Dummy</td>
</tr>
<tr>
<td>Running</td>
<td>Weekly participation in running (1 = yes)</td>
<td>Dummy</td>
</tr>
<tr>
<td>Soccer</td>
<td>Weekly participation in soccer (1 = yes)</td>
<td>Dummy</td>
</tr>
<tr>
<td>Tennis</td>
<td>Weekly participation in tennis (1 = yes)</td>
<td>Dummy</td>
</tr>
<tr>
<td><strong>Socioeconomic factors (individual level)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>Personal income in thousands = household net income (Euros per month)/number of persons in the household</td>
<td>Metric</td>
</tr>
<tr>
<td>Time</td>
<td>(a) Work time resp. school time (hours/week)</td>
<td>Metric</td>
</tr>
<tr>
<td></td>
<td>(b) Time for upbringing of children/care of relatives (hours/week)</td>
<td>Metric</td>
</tr>
<tr>
<td>Human capital</td>
<td>Level of education (1 = A-levels and higher)</td>
<td>Dummy</td>
</tr>
<tr>
<td>Age</td>
<td>Age (years)</td>
<td>Metric</td>
</tr>
<tr>
<td>Foreign nationality</td>
<td>Person has a foreign nationality (1 = yes)</td>
<td>Dummy</td>
</tr>
<tr>
<td>Gender</td>
<td>0 = male, 1 = female</td>
<td>Dummy</td>
</tr>
<tr>
<td><strong>Sport infrastructure factors (suburb level; supply per 1000 inhabitants in every suburb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport halls</td>
<td>Number of sport halls</td>
<td>Metric</td>
</tr>
<tr>
<td>Sport fields</td>
<td>Number of sport fields</td>
<td>Metric</td>
</tr>
<tr>
<td>Pools</td>
<td>Number of swimming pool</td>
<td>Metric</td>
</tr>
<tr>
<td>Tennis courts</td>
<td>Number of tennis courts</td>
<td>Metric</td>
</tr>
<tr>
<td>Park area</td>
<td>Park area</td>
<td>Metric</td>
</tr>
</tbody>
</table>

Table 1. Variables of the multi-level analyses and their operationalization.
on the infrastructure level to the individual level (for an overview about the importance of multi-level perspective, though used qualitatively see Lim et al., 2011). Moulton (1990) suggested using clustered standard errors. Yet, Cheah (2009) points out that multi-level modeling outperforms the use of clustered standard errors as its rejection rate for the null hypothesis is higher than that of hierarchical models. Another advantage of using multi-level models is that the entire process is modeled fully and it allows measurement of the explanatory power at the different levels (Primo, Jacobsmeier, & Milyo, 2007). An advantage of the clustered standard errors is that fewer assumptions are required, yet all methodological choices have such trade-offs (Primo et al., 2007). Due to the various advantages, multi-level modeling was used in the current study.

A further advantage of using a multi-level approach can be identified considering sample sizes. The sample size of the individual level consisted of 9302 cases while the sample size for the infrastructure level consisted of 53 suburbs. In multi-level analyses two separate data-sets are required, and the models are estimated simultaneously on each level (Raudenbush, Bryk, Cheong, Congdon, & Du Toit, 2004). In contrast, in conventional regression analysis, the infrastructure data would be part of the individual data-set and consequently amounting to 9302 cases leading to estimation biases due to non-independence of observations. As a result, multi-level analyses must be applied when using hierarchical data, as only this type of procedure measures and analyzes the data on the appropriate level (Osborne, 2000). An alpha-level of 0.1 is used for all statistical tests.

The evaluation of the multi-level models is undertaken in three steps. (1) The reliability is presented for each model, following an approach of Raudenbush and Sampson (1999) who recommend assessing this value. (2) The chi-square statistic is used to evaluate whether the model predicts better than chance (Tabachnick & Fidell, 2007). (3) Finally, $R^2$ will be provided for both levels. Nevertheless, it is quite challenging to estimate $R^2$ in multi-level analyses as error variances can be observed on both the individual and infrastructure level. The procedure suggested by Snijders and Bosker (1994) was used to obtain $R^2$ for both levels. The estimated values for $R^2$ on both levels can become negative, which can be ‘an undesirable feature of these statistics’ (Snijders & Bosker, 1994, p. 357). Yet, the authors argue that population values for correctly specified models are nonnegative. This feature of the $R^2$ statistic in multi-level modeling can be an advantage as it represents a diagnostic for misspecification (Snijders & Bosker, 1994). This means that the results must be doubted when the $R^2$ on one or both levels is negative. When estimating the four models, a negative $R^2$ was obtained for swimming and soccer. Therefore, a more parsimonious model was chosen and the income variable was deleted as it was not significant in either model. In addition, for the soccer model the area of sport fields was included instead of the number. In the model summary, the coefficients that have to be interpreted are displayed as in conventional regression analysis. Unfortunately, no probability of error ($p$) for the overall model can be provided in multi-level analyses.

**Results**

The descriptive statistics of the dependent variables and the socioeconomic factors are summarized in Table 2. The most often practiced amongst the four sports investigated is running: 21% of the respondents in the investigated municipalities...
take part in running, 14% go swimming at least once per week, 10% play soccer on a regular basis, and 4% play tennis. With regard to the structure of the sample, 52% of the respondents are female and 3% have a foreign nationality. The mean age is 39 years and 35% of the respondents have at least A-levels (the university entrance diploma in Germany). The average income amounts to €1040 per month, with an average working time of about 25 hours per week. Additionally, 12 hours per week are invested in childcare and care of relatives (see Table 2).

The descriptive statistics for sport infrastructure are shown in Table 3. The results indicate that one sports hall is available to 1850 people and that 6.4 sport fields are available per 1000 inhabitants. One swimming pool is shared by 7000 people and one tennis court is used by 1750 people. With regard to tennis courts, the majority of the facilities are outdoor courts. There is an area of 33,050 m² of park area available per 1000 inhabitants, meaning that each inhabitant can enjoy 33.05 m² of parks, forests, and lakes (see Table 3).

The results of the four estimated multi-level models are summarized in Table 4. The results reveal significant differences between the determinants of participation in swimming, running, soccer, and tennis. It can be seen that human capital significantly influences running and tennis participation. As the influence is positive, it can be said that the higher the education the more likely it is that someone takes part in these sports. An increase in working time is negatively associated with taking part in swimming, while positively associated with participation in running and soccer. Time for childcare and care of relatives strongly correlates with participation in swimming, running, and tennis. The influence of investing time for care also correlates negatively with taking part in swimming and tennis. In contrast, people with a high weekly time investment for care of children or relatives are more likely to participate in running. Age correlates significantly with participation in all four sports. However, divergent results emerged. A negative relationship can be observed for swimming and soccer, which means that the younger a person is, the more likely it is that he or she takes up swimming or soccer. In contrast, age positively correlates with the participation in running and playing tennis, suggesting that older people are more likely to practice these sports. Similar confounding results concern the variable gender with regard to participation. The results suggest that gender is correlated with all four sports – however with different directions. Men tend to play soccer and

**Table 2. Summary statistics for the individual level.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swimming</td>
<td>.14</td>
<td>.34</td>
</tr>
<tr>
<td>Running</td>
<td>.21</td>
<td>.41</td>
</tr>
<tr>
<td>Soccer</td>
<td>.10</td>
<td>.30</td>
</tr>
<tr>
<td>Tennis</td>
<td>.04</td>
<td>.19</td>
</tr>
<tr>
<td>Income (in 1000€)</td>
<td>1.04</td>
<td>2.51</td>
</tr>
<tr>
<td>Working time (in hours/week)</td>
<td>24.68</td>
<td>20.19</td>
</tr>
<tr>
<td>Time for upbringing children/care of relatives (in hours/week)</td>
<td>11.75</td>
<td>30.56</td>
</tr>
<tr>
<td>Human capital (1 = at least A-levels)</td>
<td>.35</td>
<td>.48</td>
</tr>
<tr>
<td>Age</td>
<td>38.90</td>
<td>21.30</td>
</tr>
<tr>
<td>Foreign nationality</td>
<td>.03</td>
<td>.16</td>
</tr>
<tr>
<td>Gender (1 = female)</td>
<td>.52</td>
<td>.50</td>
</tr>
</tbody>
</table>
tennis, while women favor swimming and running. There is no significant effect of having a foreign nationality on participation in the four sports under investigation.

On the infrastructure level, several interesting findings emerge. The presence of sport halls is negatively correlated with the participation in soccer, which means that if a sport hall is available, participation in soccer is likely to be lower. Sport fields have a positive relationship with soccer participation as well as with participation in tennis. Swimming pools have a significant negative relationship with running. Just as the presence of sport fields positively correlates with tennis participation, tennis courts conversely correlate positively with soccer participation. Finally, park area has a significant and positive relationship with participation in swimming and running, whereas tennis correlates negatively with the presence of park area.

The model assessment indicates satisfactory values for the $R^2$ of different levels. Regarding the swimming and soccer model, $R^2$ for the individual level reveals rather low values for both models ($R^2 = 4.4\%$ for swimming and $R^2 = 11.9\%$ for soccer), while higher values for the infrastructure level are obtained ($R^2 = 16.9\%$ for swimming and $R^2 = 44.9\%$ for soccer). The estimated models for running and tennis have high $R^2$ values on both levels. In the running model, the individual level variables explain 40.1\% of the variation in running participation, and on the infrastructure level, the five sport infrastructure variables explain 62.0\% of the variation in running. Regarding tennis, $R^2$ on the individual level can be reported with 49.1\% and on the infrastructure level with 62.7\%.

### Discussion

This study sets out to determine the importance of different types of sport infrastructure for participation in four sports (swimming, running, soccer, and tennis). The results show that participation in these sports is not only influenced by socioeconomic factors, but that the presence of different types of sport infrastructure is also important. The following paragraphs evaluate the results found in the multi-level modeling both on the individual and the infrastructure level in the four sports under investigation.

Consistent with findings from previous research, swimming and running are among the most practiced sports, whereas the demand for tennis is relatively lower (Hallmann, Breuer, & Wicker, 2010; Sport England, 2010). From the general statistics about the surveyed area (see Table 3) it can be seen that there is a large discrepancy among the available sport infrastructure in terms of facilities offered per 1000 residents. While there is a large difference between the amount of inhabitants per swimming pool (one pool for 7000 inhabitants) and tennis courts (one for 1000

### Table 3. Summary statistics for the infrastructure level (values per 1000 inhabitants).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sport halls</td>
<td>.54</td>
<td>.49</td>
</tr>
<tr>
<td>Sport fields</td>
<td>6.39</td>
<td>28.63</td>
</tr>
<tr>
<td>Pools</td>
<td>.13</td>
<td>.19</td>
</tr>
<tr>
<td>Tennis court</td>
<td>.57</td>
<td>.91</td>
</tr>
<tr>
<td>Park area</td>
<td>33,050.27</td>
<td>84,165.99</td>
</tr>
</tbody>
</table>
Table 4. Results of the multi-level analyses (displayed are the coefficients).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Swimming</th>
<th>Running</th>
<th>Soccer</th>
<th>Tennis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-1.610^*$</td>
<td>$-3.046^*$</td>
<td>$-.095$</td>
<td>$-3.882^*$</td>
</tr>
<tr>
<td>Income</td>
<td>$0.009$</td>
<td>$0.014^*$</td>
<td>$0.015^*$</td>
<td>$0.009^*$</td>
</tr>
<tr>
<td>Human capital</td>
<td>$0.116$</td>
<td>$0.369^*$</td>
<td>$-0.088$</td>
<td>$0.835^*$</td>
</tr>
<tr>
<td>Working time</td>
<td>$-0.006^{**}$</td>
<td>$0.014^*$</td>
<td>$0.015^*$</td>
<td>$0.009^{****}$</td>
</tr>
<tr>
<td>Time for children/relatives</td>
<td>$-0.002^{***}$</td>
<td>$0.004^*$</td>
<td>$0.001$</td>
<td>$-0.013^{****}$</td>
</tr>
<tr>
<td>Age</td>
<td>$-0.007^*$</td>
<td>$0.029^*$</td>
<td>$-0.061^*$</td>
<td>$0.009^{****}$</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>$0.351^*$</td>
<td>$0.279^{**}$</td>
<td>$-2.566^*$</td>
<td>$-0.458^{**}$</td>
</tr>
<tr>
<td>Foreign nationality</td>
<td>$-0.017$</td>
<td>$-0.085$</td>
<td>$0.195$</td>
<td>$-0.178$</td>
</tr>
<tr>
<td><strong>Infrastructure level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sport halls</td>
<td>$-0.045$</td>
<td>$-0.108$</td>
<td>$-0.245^{****}$</td>
<td>$0.263$</td>
</tr>
<tr>
<td>Sport fields</td>
<td>$0.000$</td>
<td>$0.001$</td>
<td>$0.000^{***}$</td>
<td>$0.003^{**}$</td>
</tr>
<tr>
<td>Pools</td>
<td>$-0.069$</td>
<td>$-2.039^*$</td>
<td>$0.067$</td>
<td>$-0.362$</td>
</tr>
<tr>
<td>Tennis court</td>
<td>$-0.024$</td>
<td>$0.011$</td>
<td>$0.073^{***}$</td>
<td>$-0.11$</td>
</tr>
<tr>
<td>Park area</td>
<td>$0.000^{**}$</td>
<td>$0.000^{**}$</td>
<td>$-0.000$</td>
<td>$-0.000^{****}$</td>
</tr>
<tr>
<td><strong>Model assessment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variance individual level ($\sigma^2$)</td>
<td>$0.118$</td>
<td>$0.168$</td>
<td>$0.091$</td>
<td>$0.037$</td>
</tr>
<tr>
<td>Variance infrastructure level ($\tau_{\infty}$)</td>
<td>$0.029 (\chi^2 = 72.52^{**})$</td>
<td>$0.106 (\chi^2 = 136.85^*)$</td>
<td>$0.014 (\chi^2 = 53.211^{****})$</td>
<td>$0.047 (\chi^2 = 43.379)$</td>
</tr>
<tr>
<td>Intra-class correlation ($\rho$)</td>
<td>$0.197$</td>
<td>$0.387$</td>
<td>$0.134$</td>
<td>$0.556$</td>
</tr>
<tr>
<td>Reliability ($\lambda$)</td>
<td>$0.999$</td>
<td>$0.999$</td>
<td>$0.998$</td>
<td>$0.999$</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>$3021.034^*$</td>
<td>$10,954.604^*$</td>
<td>$2506.406^*$</td>
<td>$8264.375^*$</td>
</tr>
<tr>
<td>$R^2$ individual level</td>
<td>$4.4%$</td>
<td>$40.1%$</td>
<td>$11.9%$</td>
<td>$49.1%$</td>
</tr>
<tr>
<td>$R^2$ infrastructure level</td>
<td>$16.9%$</td>
<td>$62.0%$</td>
<td>$44.9%$</td>
<td>$62.7%$</td>
</tr>
</tbody>
</table>

*p <.001; **p <.01; ***p <.1; ****p <.05.
inhabitants), it must be taken into consideration that one pool is able to cater to many more participants at one time than one tennis court.

On the individual level, the results of the socioeconomic factors yielded some interesting findings. In contrast to what was posited regarding general sport participation (Berger et al., 2008; Humphreys & Ruseski, 2009; Ifedi, 2008), income played no role in for people taking part in running or tennis. This can be explained by the rather high-average income of the sample which seems to represent no restriction to participation in the four sports under investigation. In a recent study from Canada it was found that, 'when significant, people with higher income are more likely to participate, but conditional on participation, spend less time' (Humphreys & Ruseski, 2010, p. 27). Yet, it has to be noted that Downward (2004) found a significant positive impact of income on participation in swimming and running, although infrastructure was not taken into consideration in his study.

Human capital was shown to significantly influence participation in running and tennis, which is congruent with previous findings for general sport participation (Ifedi, 2008; Scheerder et al., 2006). People who are more educated may understand the positive effects that sports such as running have on the body. In addition, those who practice tennis tend to be more educated. The positive effect of working time on running was expected, as running should be the least time-consuming sport of the four sports under investigation. Moreover, running is not bound to specific time restrictions such as opening hours of sport halls or swimming pools. People who work full-time can go running in the morning before work or in the evening after work, or even during the lunch break. Furthermore, no time arrangements with other people are necessary as an individual can go running on her or his own. In contrast, time arrangements with another player are needed for tennis, and even more players are needed for soccer. Therefore, the result that working time has a positive influence on soccer participation is surprising. It is suggested that making time arrangements with other players and making a sport field or sport hall available at that specific time should be difficult for people who have a high weekly workload. However, as regular (at least once per week) sport participation was assessed in the current study, it is also possible that people with a high weekly workload play soccer at the weekend. The negative effect of working time on participation in swimming can be explained by the time restrictions of swimming in public pools. It is suggested that people with a high weekly workload start working early in the morning and finish work late in the evening. Many public swimming pools do not open in the morning or are not open anymore in the evening when these people finish work. In Germany, many public swimming pools have restricted opening hours for the public as the pools are also used by schools (in the morning) and sport clubs (in the evening).

The weekly time for care of children or relatives negatively affects participation in tennis and swimming, whereas it has a positive influence on running participation. As previously explained, running does not require much time and no time arrangements with other people or with the opening hours of sport facilities. In fact, children can also be part of the activity and accompany the participant in a sport stroller or on a bike when they are older which can be often seen in parks – although this is rather anecdotal evidence. In contrast, swimming and tennis are more difficult to practice for people with children or who have to care for relatives, as someone needs to take care of them during the activity. The opening hours of public
swimming pools and the availability of tennis courts can represent a restriction to them. As previously mentioned, many public pools have restricted opening hours for the public, and tennis courts have to be booked. Due to the implementation of all-day schools in Germany during recent years, the tennis courts in many sport clubs are no longer reserved for adults in the evening. Some years ago, the courts were reserved for adults in the evening (e.g. from 5 pm onward) since children attended school in the afternoon only on 1 or 2 days per week and therefore could practice in the afternoon. Moreover, children cannot be left unattended while the adult practices tennis or swimming. Childcare services are usually not available at swimming pools or at tennis clubs. However, it also has to be noted that many females go swimming with their children.

With regard to age, the negative impact on swimming and soccer is consistent with previous findings (Downward, 2004). Nevertheless, the negative age effect on swimming participation is surprising. As swimming is a sport that can also be practiced with low intensity (i.e. it is not a high intensity sport per se) and is therefore also practicable for older people with decreasing physical abilities, it would have been expected that older people are more likely to participate in swimming. In fact, the positive age effect in the model for running supports the fact that older people prefer running. However, this positive age effect contradicts previous research (Downward, 2004). The gender effect produced mixed results: men participate in soccer and tennis, whereas women tend to prefer running and swimming. This is partly consistent with previous findings indicating that women take part significantly more often in swimming and men in playing soccer and running (Downward, 2004). Based on the findings of this study, the assumption can be made that men take part in more time-consuming sports and sports where other players are necessary, whereas women participate in sports where other participants are not necessary to practice the sport. It seems that women do not seek competition to the same degree as men do and therefore prefer non-competitive or health-related sports such as swimming. This survey yielded no significant results with regard to foreign nationality, which is divergent from previous studies (Amara & Henry, 2010; Maxwell & Taylor, 2010), although those studies only looked at sport participation in general. The findings of the current study support the assumption that having a foreign nationality seems to have only an impact on the decision whether an individual takes part in sport generally. Once the individual has chosen to take part in sport, then nationality has no impact on the chosen sport.

Some interesting findings are observed at the infrastructure level. Where many sport halls are present, a negative and significant relationship with soccer is detected, that means participation in soccer is lower where many sport halls are present. One reason for this finding might be that sports other than soccer are practiced when many sport halls are available. The presence of sport fields has a significant and positive relationship with participation in soccer. In Germany, sport clubs usually offer their soccer training on sport fields which can explain why the availability of sport fields had a positive relationship with soccer participation. Moreover, participation in tennis correlates positively with sport fields. This may be due to the frequent proximity of the facilities to one another. In this study, outdoor tennis courts accounted for a majority of the tennis courts. Due to the fact that outdoor tennis courts are often located near outdoor soccer fields, as mentioned by the municipalities under investigation, this interpretation seems reasonable. Moreover, as
with the influence of sport fields on tennis participation, tennis courts have a positive and significant relationship with soccer participation in turn which might be accounted for by the proximity of those facilities in the municipalities under investigation.

Furthermore, the negative relationship between swimming pools and running participation in this study can possibly be explained by the fact that some people go running when there is no facility available to go swimming. Both sports are individual sports in which endurance plays a major role. The pace and intensity of the sporting performance can be decided each time individually based on the current physical mood. Consequently, swimming could be substituted by running when there is a lack of available pools. Park areas positively correlate with swimming participation which can be explained by the proximity of lakes to some parks. Given the good water quality of lakes in Germany, open water swimming can be practiced in lakes. This finding is in accordance with previous research (Cerin & Leslie, 2008). For all infrastructure effects in the models it has to be noted that if a sport-specific facility (e.g. a pool) had no relationship with participation in the specific sport (e.g. swimming), it can be assumed that supply meets demand.

Park area correlates positively with running, which can be accounted for by running trails that are often provided in park areas. Although running can be practiced nearly anywhere and no specific facility per se is needed, it is suggested that people prefer running in parks than on the street next to the traffic. In contrast, tennis has a negative relationship with the presence of park areas. This implies that the availability of parks decreases participation in tennis, indicating that sports such as running or hiking are preferred over tennis when parks are available.

The model assessment reveals that besides the variables of the socioeconomic part of the model, the infrastructure variables are also of importance when predicting sport participation. The rather low values for $R^2$ on the individual level for swimming and soccer are common results in social science and in previous research on sport participation focusing only on one level (e.g. Humphreys & Ruseski, 2007). In fact, the high values for $R^2$ on the infrastructure level point to the importance of providing infrastructure for participating in different sports. In all four multi-level models, the $R^2$ for the infrastructural level was higher than for the individual level.

The current study has some limitations. The first limitation relates to the structure of the sample. As the sample examined is very specific and all municipalities are situated in rather rural areas (yet being representative for each municipality), the results of the current study can only be generalized with caution. Moreover, the current study is only based on cross-sectional data. This means that no developments in sport participation can be measured, only the status quo at the time of the survey. Second, it has to be noted that distances to the facilities were not included in the model as this information was not available. Third, the infrastructure data is restricted to suburbs. However, it is possible that people also use the sport infrastructure of neighboring suburbs.

Despite these limitations, the current study has some implications for policymakers. Policy makers have to take several aspects into account when making city planning. They may need to take into consideration the nature of the municipality with regard to existing sport infrastructure, space available for expansion, and the needs of its inhabitants when aiming at increasing sport participation. When city planning takes place, planners may need to consider what type of sport infrastructure
is already present and also the proximity of public transportation to sport facilities in order to maximize potential for sport participation. In addition, planners may need to assess what space they have available for new sport facilities, and what facilities would best fit the needs of the residents of the municipality. For example, policy makers may also need to take into consideration the special needs of certain groups, such as Muslim women, for whom, due to their religious views, sport facilities might need to be tailored to their sporting interests (Amara & Henry, 2010). In particular, when the municipality is aware of a lack of swimming pools and has no financial means to build an additional pool, but still wants to promote sport participation, running could be promoted, perhaps by highlighting the available park areas, and by indicating specific running tracks and providing road signs as a positive relationship was detected. It must be noted that if governments or municipalities want to promote sport participation, they could focus on the provision of adequate sport infrastructure. Although some characteristics of the individuals such as motivation (i.e. through motivation campaigns) or education (i.e. through investments in education and formation) can be altered, many individual characteristics such as age, gender, or nationality cannot be changed. Consequently, promoting sport participation in different sports through an increased supply of specific sport infrastructure seems to be a better starting point.

Conclusion

The purpose of this research was to examine the importance of sport infrastructure for sport participation in different sports. The study showed that, in addition to socioeconomic factors on the individual level, infrastructure-level variables are also important predictors of sport participation in diverse sports. The current study contributes to the literature on sport participation by also taking sport infrastructure variables into account and by applying appropriate multi-level analyses to the hierarchical (multi-level) data.

Future research should integrate variables which include the available time in the facility to participate in the sports examined. For example, the opening times of sport halls or swimming pools would be interesting to examine to better understand further restrictions to sport participation from an infrastructure perspective. It may also be interesting to assess the perceptions of survey participants and what facilities they think are available to them. In many cases, people are not aware of the facilities (and programs) which are in fact available. An interesting question to pursue would be the effects of the state the infrastructure is in on sport participation (e.g. how does a high-quality facility affect sport participation?). Therefore, comparing subjective and objective measures of sport infrastructure in one study could lead to fruitful results. In addition, particular sport programs by non-profit sport clubs and commercial providers could be examined by integrating a third level into the model concerning the sport programs offered in the specific municipality. Motives for participating in sport and cultures surrounding sport are possible areas of future investigations where further explanations for specific results can be illuminated. Another theme that needs further investigation is possible substitution effects among different sports performed. This research has given some hints in this respect, yet this area is still underresearched. In this context it could be interesting to see whether for example participation in soccer has an impact on swimming participation.


