Greier K[1], Brunner F[2], Riechelmann H[3]

Size of Community and Motor Performance in Preschool Children

Wohnortgröße und motorische Leistungsfähigkeit von Kindergartenkindern

[1]Pädagogische Hochschule (KPH-ES) Stams, Bewegungs- und Sporterziehung, Österreich
[2]Institut für Sportwissenschaften, Universität Innsbruck, Österreich
[3]Medizinische Universität Innsbruck, Österreich

ZUSAMMENFASSUNG

Problemstellung: Bewegung zählt zu den wichtigsten Faktoren, die bei der psychomotorischen Gesamtentwicklung von Kindern eine Rolle spielen. Immer mehr Kinder in Industriestaaten leiden aber an Bewegungsmangel und die motorische Leistungsfähigkeit im Kindesalter zeigt einen negativenTrend. Es stellte sich die Frage, ob es schon im Vorschulalter Unterschiede der motorischen Leistungsfähigkeit in Abhängigkeit von der Wohnortgröße gibt. Methode: Aus 24 Kindergärten in ländlichen Gemeinden (< 5000EW), 12 in kleinstädtischen Regionen (5000 bis 20.000 EW) und 5 in einer Großstadt (>100.000 EW), wurden insgesamt 1063 vier- und fünfjährige Kinder rekrutiert.Zur Erfassung der motorischen Leistungsfähigkeit wurde das Karlsruher Motorik-Screening (KMS 3-6) durchgeführt. Der BMI wurde durch Körpergröße und Gewicht ermittelt.
Ergebnisse: Die höchsten KMS-Scores wurden bei Kindern aus ländlichen Wohnorten erzielt (99,2 Scorepunkte gegenüber 97,0 Scorepunkten bei Kindern aus klein- und großstädtischen Wohnumfeld; $p < 0{,}01$). Es zeigten sich keine signifikanten Geschlechtsunterschiede (♂ 99,8 vs. ♀100,1; $p > 0{,}4$). Bei einer Übergewichtsprävalenz von 13 % im Gesamtkollektiv erzielten übergewichtige Kinder mit 97,2 niedrigere Scores als normalgewichtige Kinder mit 100,4 ($p < 0{,}001$).
Schlussfolgerung: In dieser Untersuchung zeigte die motorische Leistungsfähigkeit auch bei Kindergartenkindern in Bezug auf die Wohnortgröße teilweise signifikante Unterschiede. Es erscheint daher ratsam, vermehrt Bewegungsfördermaßnahmen in Kindergärten anzubieten und dabei insbesondere urbane Siedlungsräume zu berücksichtigen.

Schlüsselwörter: Vorschule, sportmotorischer Test, Stadt-Landvergleich, körperliche Fitness

SUMMARY

Problem: Physical exercise plays a key role in the psychomotor development of young children. However particularly in developed countries an ever increasing number of children suffer from lack of exercise resulting in insufficient motoric capability. This current study on preschool kids explores a possible correlation between the size of their hometown and their motoric performance.
Method: A total of 1.063 four to five year old children were recruited from 41 kindergartens in Tyrol, Austria. 24 of these kindergartens were in rural communities (< 5.000 inhabitants), 12 in small towns (5.000 to 20.000 inhabitants) and 5 in big cities (> 100.000 inhabitants). Assessment tool for capturing the data was the Karlsruher Motorik-Screening (KMS 3-6).
Results: The highest KMS-scores were achieved by children in rural areas (99.2 score points; $p < 0.01$). Gender-related differences were not significant (♂ 99.8 vs. ♀ 100.1; $p > 0.4$). Differences between normal weight (100.4 score points) and overweight (97.2 score points) children however were significant ($p < 0.001$). Overweight/obesity was observed in 13% of the study population.
Conclusion: The study shows considerable varieties regarding motoric capabilities of kindergarten children with reference to the size of their hometown. It seems highly advisable to encourage and facilitate physical exercise in kindergartens particularly in urban settlements.

Key Words: preschool, motor-performance diagnostics, urban-rural relation, fitness

INTRODUCTION

The children's world of movement has changed drastically during the last decades in western industrial nations and is characterised more and more by a reduction of daily physical activities and by a general lack of movement (3,6,21,29). Besides genetic factors, the children's movement behaviour is mainly influenced by environmental factors (16). In this context, the residential environment plays a central role.

Differences in motor performance capabilities in relation to the population size of the place of residence have been the focus of several studies (5,7,10,12,20,29,31). In most of these studies, the place of residence has been differentiated by the size of the population using rural areas, small, medium and metropolitan communities as categories (24). Yet, these published studies show no consistent results.

For example, Zimmer (31), Majerus (20) and Greier et al. (10) were able to prove a significant influence of the residential environment on the motor performance capabilities. They interpreted their results as a consequence of the reduction of areas suited for movement and physical activity caused by the increased population density and traffic. In contrast, Gaschler (7) and Joens-Marte et al. (12) found no relation between the motor performance capabilities and the size of the population.

Further, the results of the MOMO study conducted in Germany show that the motor performance capabilities of children and

accepted: May 2013
published online: October 2013
DOI: 10.5960/dzsm.2012.075
Greier K, Brunner F, Riechelmann H: Wohnortgröße und motorische Leistungsfähigkeit von Kindergartenkindern. Dtsch Z Sportmed 64 (2013) 301 - 306.

juveniles from rural and urban areas do not differ (29), but that children and juveniles from rural areas have a twice as high chance of being physically active outdoors at least four times a week (27).

Ketelhut et al. (15) have studied the effects of the social influences in urban settings on the motor performance capabilities and the activity levels in kindergarten-aged children. They report that children from urban and metropolitan areas have been deprived of adequate levels of areas suited for physical activity and movement by urban housing conditions and that active leisure time behaviour is often replaced by passive media consumption (15). Their study analysed the effects of social influences on the motor performance capabilities in the urban area of Berlin (Germany), but it did not analyse differences between urban and rural areas.

Most studies on the motor performance capabilities in relation to the size of the population have focused on elementary school children and juveniles, while kindergarten-aged children have rarely been analysed in this context. This is the objective of this study, in which a representative sample of Tyrolean kindergarten children has been analysed for influences of rural and urban living areas on the motor performance capabilities. It is important to already detect deficits in the development of motor performance capabilities in kindergarten age, since children can be influenced very early and no relevant pre-existing impairments exist at this young age (14).

Several different instruments and tools (4,25,30) provide ways for testing motor performance capabilities in pre-school children. One of the best-knowntests for this is the motor test (Motoriktest) MOT 4-6 by Zimmer and Volkamer (30). The test includes 18 items and allows a classification of the general motor performance development. Conducting the tests takes a significant amount of time and is therefore hard to implement in large samples. A more time-economical alternative is the Karlsruhe motor screening (Karlsruher Motorik Screening – KMS 3-6) developed by Bös et al. (4). This test was created in order to be practical for kindergarten children and tests the aspects of motor performance capabilities of speed strength, strength endurance, balance, coordination and flexibility. The decreasing physical fitness caused by a deficit in movement is often related to an increase in prevalence of overweight children (9,13,17). The influence of the body mass index (BMI) on motor performance capabilities has been studied extensively. Especially obesity goes in line with reduced motor performance capabilities (1,8,13). Further, differences in the prevalence of obesity in children and juveniles from urban and rural areas have also been well documented. These results are not consistent, though. Greier et al. (11) was able to detect higher levels of obesity in urban areas, while Joens Matre et al. (12) could not prove this in their study. That is why the BMI should be surveyed as a possible confounder in this study. Other possible confounders in this study are age and gender.

The central research question of this study was, whether there are already differences in the motor performance capabilities in kindergarten-aged children in relation to the size of the population of their place of residence.

DATA AND METHOD

In the federal state of Tyrol (Austria), around 18,000 children attended the 454 kindergartens in the school year 2011/12 (Tyrolean state government, department for education). Out of these, 77 are located in the outlying districts of Reutte and Lienz. These were not included in the study because of the high spatial distance. A random sample of 50 was chosen out of the remaining 377 kindergartens. The sample is representative for the relation between rural and urban areas in Tyrol, which is 4:3. The selected kindergartens were contacted and asked to participate in the study. Nine kindergartens were not able to participate because of organisational reasons. Accordingly, 41 kindergartens remained, from which 1,063 four to five year-olds were recruited (513 female and 550 male). The responsible carriers and the managing staff approved the study. The parents of the children were contacted by mail and asked for their approval as well.

The total number of four to five year-old children attending the selected 41 kindergartens in the school year 2011/12 was 1,082. Because of absence, for example caused by illness, two children were not surveyed in two metropolitan kindergartens, five children were not surveyed in kindergartens in small-size communities and twelve more children from eight rural kindergartens were not able to participate as well. Accordingly, 19 out of 1,082 children (1.7%) were not surveyed. This can be considered a representative sample for Tyrolean kindergarten children.

The acquisition of data about the size of the communities where the kindergartens are located was done using available data acquired in July 2011 by the Tyrolean state government (Raumordnungsstatistik). Four categories of residential areas/communities were differentiated in accordance to common criteria (24):

Rural: less than 5,000 inhabitants
Small city: between 5,000 and 20,000 inhabitants
Medium city: between 20,000 and 100,000 inhabitants
Urban/large city: more than 100,000 inhabitants

Since the state of Tyrol is for the most part rural with no medium cities and the state capital Innsbruck being the only city with more than 100,000 inhabitants (120,000), the three categories of "rural", "small city" and "urban" were finally used.
The motor tests were conducted between October 2011 and May 2012 in the kindergartens during the regular opening hours.

First, the height and weight in sports clothes without shoes were determined. The measurement of the height was done using the mobile stadiometer „SECA® 213" (Seca GmbH &Co.Kg, Hamburg, Germany) with a precision of one millimetre and the body weight was measured using the calibrated scale „GRUNDIG® 3710" (Grundig AG, Nürnberg, Germany) with a precision of 0,1 kg. These one-time tests were conducted to the most part by the lead researcher and only to a small part by staff members,which were especially trained to use the testing equipment.

Based on these measurements, the BMI was calculated using the BMI reference system by Kromeyer-Hauschild et al. (18). According to this reference system, children are considered to be normal weight, if their weight is between the 10th and the 90th percentile. Children with values under the 10th percentile are considered underweight. If the weight is between the 90th and the 97th percentile, children are considered overweight and values over the 97th percentile are considered as obese. In order to evaluate the results, the BMI values were grouped in the two groupsunderweight/normal weight (W_{low}) and overweight/obese (W_{high}).

The management of the kindergartens provided the birthdates. Only four and five year-olds were included in the sample and

were grouped in the two age groups four years (≥4 to <5 years) and five years (≥5 to <6 years).

Test Implementation

The motor performance capabilities were measured using the Karlsruhe motor screening (KMS) for kindergarten children developed by Bös et al. (4). The children received an age-specific and thorough explanation of the tests. The children were allowed to get familiar with the equipment and the tests before the actual test began. According to the provided test descriptions, the children first did a rehearsal/test runof each test. The test battery consists of the four parts "stand and reach", "one-legged stance", "standing long jump" and "side-to-side jumps".

Stand and Reach (flexibility)

This test serves the purpose of measuring the flexibility and mobility of the torso and the active stretching ability of the muscles in the rear of the trunk. During this test the upper body has to be lowered down as far as possible while keeping the legs straight. The distance between the fingers and the standing surface is measured. The standing surface is the zero point of the scale, values above the standing surface are negative, below are positive. The values are recorded in centimetres (cm).

One-legged Stance (balance)

This test measures the ability to balance while standing. The number of contacts with the floor during one minute of standing on one leg on a T-bar with eyes open is recorded. For more than 30 contacts the value 30 is recorded.

Standing Long Jump (explosive strength)

Using both legs, the child has to jump forward as far as possible. Two attempts are granted and the best distance is recorded. The child has to remain standing after the jump in order to make the jump valid.

Side-to-Side Jumps (coordination under time pressure)

This test serves the purpose of measuring total body coordination, action velocity and the strength endurance capability of the lower extremities. The child has to jump with both legs at a time from one side of a bar on the floor to the other as fast as possible for 15 seconds. The total number of successful jumps from two valid attempts are summed up and recorded.

Data Analysis/Statistics

For interval-scaled data, the statistical parameters mean (M) and standard deviation (SD) were used. Frequencies were presented in tables and diagrams. A sum score of all four tests was determined using a z-transformation (addition of all four z-values and dividing the sum by four). The values of the test item "one-legged stance" were multiplied by -1 in order to be comparable with the other three tests in which a high score indicates a good performance. The influence of the population size of the communities on this sum score was analysed using variance analysis while also considering the independent variables age, gender and BMI. A saturated type III model was constructed.The test for normal distribution of the sum score was done using the Kolmogorov-Smirnov test and the homogeneity of variances by Levene test.

Table 1: Anthropometric data of the 1,063 four- and five-year old Tyrolean kindergarten children, differentiated by population size

Population Size	Anthropometric Data	N	M	SD
<5,000 inhabitants	Age (y)	606	4,9	0,6
	Height (cm)	606	112,2	6,2
	Weight (kg)	606	19,7	3,4
	BMI (kg/m²)	606	15,6	1,8
	SDS	606	0,0	1,0
5,000 – 20,000 inhabitants	Age (y)	289	4,9	0,5
	Height (cm)	289	111,3	5,6
	Weight (kg)	289	19,6	3,3
	BMI (kg/m²)	289	15,7	2,0
	SDS	289	0,0	1,2
>100,000 inhabitants	Age (y)	168	5,0	0,5
	Height (cm)	168	112,7	6,6
	Weight (kg)	168	20,9	4,3
	BMI (kg/m²)	168	16,3	2,2
	SDS	168	0,4	1,0
total	Age (y)	1063	4,9	0,5
	Height (cm)	1063	112,0	6,2
	Weight (kg)	1063	19,9	3,5
	BMI (kg/m²)	1063	15,8	1,9
	SDS	1063	0,1	1,1

Table 2: Frequencies of the analysed factor of population size differentiated by the potential confounders included in this study gender, age and BMI group of 1,063 Tyrolean kindergarten children

Population Size	Kindergartens n (%)	Children n (%)	Gender n (%)	Age n (%)	BMI-Group n (%)
<5,000 inhabitants	24 (59)	606 (57)	f 294 (49)	4Y. 238 (39)	W_{low}: 541 (89)
			n (%)	5Y. 368 (61)	W_{high}: 65 (11)
5,000-20,000 inhabitants	12 (29)	289 (27)	f 141 (49)	4Y. 114 (40)	W_{low}: 247 (85)
			m 148 (51)	5Y. 175 (60)	W_{high}: 42 (15)
>100,000 inhabitants	5 (12)	168 (16)	f 78 (47)	4Y. 58 (35)	W_{low}: 36 (81)
			m 90 (53)	5Y. 110 (65)	W_{high}: 32 (19)
total	41 (100)	1063 (100)	f 513 (48)	4Y. 410 (39)	W_{low}: 924 (87)
			m 550 (52)	5Y. 653 (61)	W_{high}: 139 (13)

W_{low}: underweight/normal weight; W_{high}: overweight/obese

RESULTS

Out of the analysed 41 kindergartens, 24 are located in rural areas, 12 in small cities and 5 in an urban area/large city.

The mean age of the analysed kindergarten children was 4.9 ±0.5 years and the mean BMI was 15.6 ±1.9. The standard deviation score (SDS) according to the Kronmeyer-Hauschild et al. (18) calculation was 0.07+/- 1.1 (M+/- SD). Hence, the children were on average at the 50th percentile with a standard deviation between

Table 3: Mean values of the sum scores of motor performance capabilities of Tyrolean kindergarten children (n=1,063), differentiated by the population size and cleansed of the effect of age, gender and BMI (estimated residuals)

Population Size	Mean Sum Score	95% CI	n	p	F
<5,000 inhabitants	99,2	98,4 - 100	606		
5,000-20,000 inhabitants	97	96,1 – 98,0	289	0,005	5,4
>100,000 inhabitants	98,5	97,2 – 99,8	168		

Table 4: Uncleansed mean values and standard deviations of the sum scores for motor performance capabilities of Tyrolean kindergarten children (n=1,063) differentiated by age, gender and BMI.

Characteristic		Mean Sum Score	SD	n	p	F
gender	m	99,8	6,5	550	>0,4	0,6
	f	100,1	6,6	513		
age	4 y.	97,1	5,6	410	<0,001	144
	5 y.	101,8	6,4	653		
BMI group	W_{low}	100,4	6,5	924	<0,001	29,1
	W_{high}	97,2	6,1	139		

W_{low}: underweight/normal weight; W_{high}: overweight/obese

the 16th and 84th percentile. The lowest measured SDS was -3.6 (below the 1st percentile) and the highest was 3.8 (above the 99th percentile) (Tab. 1).

The frequency distribution of age group and gender of the analysed 1,063 children was similar in all three population-size categories. The classification by BMI groups (underweight/normal vs. overweight/obese) did not show a consistent distribution in the three population-size categories. Almost twice as many overweight/obese children were recorded in the urban area/large city (19%) compared to rural areas with only 11% (Tab. 2).

The sum scores of the motor performance capabilities, differentiated between the three categories of population size, differ significantly after being cleansed from the effects of age, gender and BMI (p = 0.005; Tab. 3). Multi-factorial analysis of variances did not show interaction effects with a p-value of <0.15.

The sum scores of the KMS test show no significant gender differences (p>0.4). Yet, the differences between the two age groups and the two BMI groups were highly significant (Tab. 4).

Looking at the results of the individual test items in detail, the kindergarten children from rural areas achieved significantly higher scores (p<0.05) at the test items "one-legged stance" and "side-to-side jumps" compared to the children from small cities. Compared to the kindergarten children from large cities, the children from rural areas scored significantly higher (p<0.05) in the test items "standing long jump" and "one legged stance" (Fig.1).

DISCUSSION

1.063 four- and five-year old children from 41 Tyrolean kindergartens were tested for their motor performance capabilities using the KarlsruherMotorik Screening (KMS 3-6). Looking at the sum scores of the KMS 3-6, differences between children from rural and urban areas are observable. These differences indicate higher motor performance capabilities in children from rural areas. This result is consistent with other studies on school children (5,6) and kindergarten children (10,20,31), where other test tools like the KTK (25) and MOT 4-6 (30) were used besides the KMS 3-6.

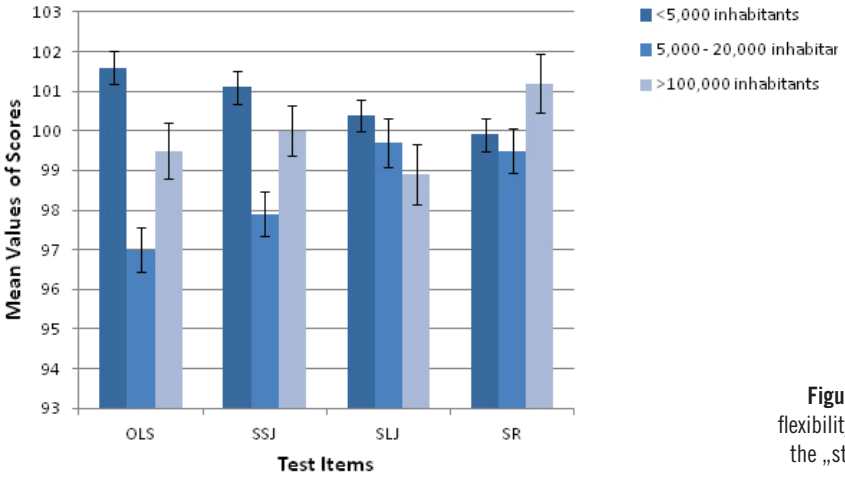
Majerus (20), for example, was able to record highly significantly higher scores of children from rural areas using the motor test MOT 4-6 in his study on 110 preschool children from Luxembourg. Further, Zimmer (31) determined a significant correlation between the residential environment and the motor performance capabilities using the body coordination test "Körperkoordinationstest" (KTK) and MOT 4-6. The authors explain these increased motor performance capabilities by referring to the more available movement opportunities and more active leisure time behaviour. In contrast to these studies, Joens-Matre et al. (12) did not find any correlations between motor performance capabilities and the size of the residential community when analysing data on school children from the USA.

The results from the motor test section of the KiGGS study conducted in Germany did show a significant influence of the residential environment on physical and sport-related activity levels. Children from rural areas were more active in their leisure time than children from urban areas (27). Full-day care is more common in urban schools and kindergartens compared to rural areas with mostly half-day care schools and kindergartens, which may limit more active leisure time activities. Yet we assume that the higher scores in rural kindergartens are not caused by differences in the promotion of sport-related motor skills. Rather, the assumption that several different factors are causing these differences is made. In this study the known determinants age and BMI show the expected effects on the children's motor performance capabilities proven in previous studies (3,9,26,29). Using a multifactorial approach in this study, the effect of the residential environment was cleansed of these confounders. No influence of the gender on the sum score of the KMS 3-6 was detected. Bappert and Bös (2) were also able to show in their longitudinal study that the motor performance capabilities of preschool-aged girls and boys hardly differ.

Breaking down the results of the KMS 3-6 into the individual test items, it showed that children from more rural areas with small towns (<5.000 inhabitants) scored significantly higher in the two test items "one-legged stance" and "side-to-side jumps", compared to the group of children from smaller cities (5.000 to 20.000 inhabitants). In the test items "standing long jump" and "stand and reach" (Fig. 2) the children from rural areas scored only slightly higher than the children from small cities (p>0.05).

The differences between rural and urban areas did not show as distinctly in Innsbruck, the only large city in Tyrol. Looking at the results of the individual test items, it shows that the children from the large city scored significantly lower in the items "one-legged stance" and "standing long jump" compared to children from more rural areas while no significant differences were detected in the "side-to-side jumps". When testing for flexibility ("stand and reach"), the children from Innsbruck achieved higher scores than the children from other residential environments. Yet, these differences are not statistically significant (p>0.05).

In conclusion, the KMS 3-6 proved to be highly practicable. The results are easy to compare to other results of KMS 3-6 tests (4,10,15).



Firgure 1: Individual scores (Z-values; mean +/- standard deviationof the mean) for the four test items one-legged stance (OLS), side-to-side jumps (SSJ), standing long jump (SLJ) und stand and reach (SR), differentiated by population size

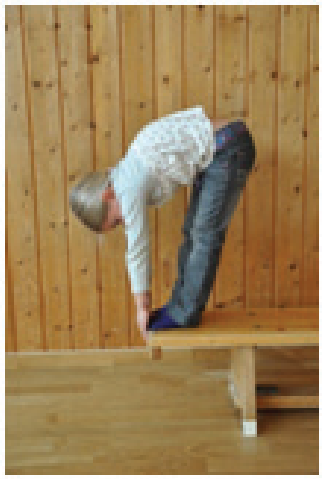


Figure 2: Testing for flexibility/mobility using the „stand and reach" test

The size of the community already affected the motor performance capabilities of children in kindergarten age. The influence of the size of the community was significant in this study, yet the effect was not very distinct. The analysis of variances of the scores for motor performance capabilities shows that the variance in the sample can be explained by around 10% by the urban and rural residential area (partial Eta^2 = 0.01).

Under the assumption of a connection between physical activity, motor performance capabilities and the health status, a minimum amount of sports or physical activity per day is considered inevitable in order to provide for the health and wellbeing of children. In order to fulfil the daily requirements for total physical activity and movement, the WHO suggests that children should be physically active for at least 60 minutes a day at moderate to high intensities (28). However, national and international studies prove that around two thirds of all kindergarten children stay below these requirements (19,23).

Since the basis for an active lifestyle is laid in early childhood years and this basis positively affects the activity-related behaviour in the future stages of life, measures aiming at promoting physical activity are important early on (16). Kindergartens are optimal settings for these intervention measures. The data from this study suggest that measures for promoting physical activity should be increasingly offered in kindergartens, especially in areas where leisure time physical activity is hindered by a densification of the living environment. In this context Kettner et al. (16) point out that a cooperation with local sports clubs offers the opportunity to optimise these offers, especially in full-day kindergartens, in regard to the promotion of physical activity and the transfer of the sensation of joy and fun of being physically active.

LIMITATIONS

The socioeconomic status of the family also has an important influence on the motor performance capabilities (15,22). The residence in a wealthier or a less wealthy neighbourhood of a city has been used as a surrogate marker for the socioeconomic status. This was obviously not possible for this study. The acquisition of the socioeconomic status using more complex methods was not possible in this study for research-economical reasons, which constitutes a major limitation of this study. No reliable data on differences in rural and urban social structures in Tyrol is available at this time.

Beyond, other potential confounders were not considered. For example, full-day care is offered more often in urban kindergartens and schools, which may possibly further limit active forms of leisure time compared to rural areas. The leisure time activities (volume and intensity of physical activity) were not surveyed in this study.

Conflict of interest

The author has no conflicts of interest.

LITERATURE

1. **Bappert S, Woll A, Bös K:** Motorische Leistungsunterschiede bei über- und normalgewichtigen Kindern im Vorschulalter. Haltung und Bewegung 23 (2003) 35-37.
2. **Bappert S, Bös K:** Motorische Entwicklung im Vorschulalter. Sportunterricht 56 (2007) 40-44.
3. **Bös K:** Motorische Leistungsfähigkeit von Kindern und Jugendlichen, in: Schmidt W, Hartmann-Tews I, Brettschneider W (Hrsg): Erster Deutscher Kinder- und Jugendbericht. Hofmann Verlag, Schorndorf 2003, 85-107.
4. **Bös K, Bappert S, Tittlbach S, Woll A:** Karlsruher Motorik-Screening für Kindergartenkinder (KMS 3-6). Sportunterricht 53 (2004) 79-87.
5. **Brinkhoff KP:** Über die veränderten Bedingungen des Aufwachsens: die Kindheit. Sportpädagogik 20 (1996) 4-6.
6. **Dordel S:** Kindheit heute: Veränderte Lebensbedingungen = reduzierte motorische Leistungsfähigkeit? Motorische Entwicklung und Leistungsfähigkeit im Wandel. Sportunterricht 49 (2000) 341–349.
7. **Gaschler P:** Motorische Entwicklung und Leistungsfähigkeit von Vorschulkindern in Abhängigkeit von Alter und Geschlecht. Haltung und Bewegung 18 (1998) 5-18.
8. **Graf C, Koch B, Kretschmann-Kandel E, Falkowski G, Christ H, Coburger S et al:** Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project). Int J Obesity 28 (2004) 22-26. doi:10.1038/sj.ijo.0802428

9. **Graf C, Kupfer A, Kurth A, Stuetzer H, Koch B, Jaeschke S, Jouc S, Lawrenz A, Predel H, Bjarnason-Wehrens B:** Effekte einer interdisziplinären Intervention auf den BMI-SDS sowie die Ausdauerleistungsfähigkeit adipöser Kinder – das CHILT III-Projekt Dtsch Z Sportmed 56 (2005) 353–357.
10. **Greier K, Winter C:** Die motorische Leistungsfähigkeit von 3-5jährigen Kindergartenkindern. Bewegungstherapie und Gesundheitssport 27 (2011) 204-207. doi:10.1055/s-0031-1283732
11. **Greier K, Riechelmann H:** Einfluss des Migrationsstatus auf die motorische Leistungsfähigkeit im Kindergartenalter. Bewegungstherapie und Gesundheitssport 28 (2012) 248-253. doi:10.1055/s-0032-1325221
12. **Joens-Matre R, Welk G, Calabro M, Russel D, Nicklay E, Hensley L:** Rural-urban differences in physical activity, physical fitness and overweight prevalence of children. J Rural Health 24 (2008) 49-54. doi:10.1111/j.1748-0361.2008.00136.x
13. **Kaspar T, Korsten-Reck U, Rücker G, Jotterand S, Bös K, Berg A:** Sportmotorische Fähigkeiten adipöser Kinder: Vergleich mit einem Referenzkollektiv und Erfolge des Therapieprogramms FITOC. Aktuel Ernaehr Med 28 (2003) 300-307. doi:10.1055/s-2003-42514
14. **Ketelhut K:** Motorische Tests im Setting Kindergarten. Bewegungstherapie & Gesundheitssport 22 (2006) 238-240. doi:10.1055/s-2006-942322
15. **Ketelhut K, Strang H, Holzweg M:** Einfluss des sozialen Einzugsgebiets auf die motorische Leistungsfähigkeit und das Aktivitätsverhalten im Kindergartenalter. Dtsch Z Sportmed 62 (2011) 47-51.
16. **Kettner S, Wirt T, Fischbach N, Kobel S, Kesztyüs D, Schreiber A, Drenowatz C, Steinacker JM:** Handlungsbedarf zur Förderung körperlicher Aktivität im Kindesalter in Deutschland. Dtsch Z Sportmed 63 (2012) 94-101.
17. **Korsten-Reck U, Kaspar T, Korsten K, Kromeyer-Hauschild K, Bös K, Berg A, Dickhuth H:** Motor Abilities and Aerobic Fitness of Obese Children. Int J Sports Med 28 (2007) 762-767. doi:10.1055/s-2007-964968
18. **Kromeyer-Hauschild K, Wabitsch M, Kunze D, Geller F, Geiss HC, Hesse V, von Hippel A, Jaeger U, Johnsen D, Korte W, Menner K, Müller G., Müller JM, Niemann-Pilatus A, Remer T, Scaefer F, Wittchen H, Zabransky S, Zellner K, Ziegler A, Hebebrand J:** Perzentile für den Body-Mass-Index für das Kinder- und Jugendalterunter Heranziehung verschiedener deutscher Stichproben. Monatsschr-Kinderheilkd 149 (2001) 807-818. doi:10.1007/s001120170107
19. **Krug S, Jekauc D, Poethko-Müller C, Woll A, Schlaud M:** Zum Zusammenhang zwischen körperlicher Aktivität und Gesundheit bei Kindern und Jugendlichen. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 55 (2012) 111-120. doi:10.1007/s00103-011-1391-1
20. **Majerus V:** Vorschulkinder in Luxemburg. Untersuchung zur motorischen Lesitungsfähigkeit. Diplomica Verlag, Hamburg, 2010.
21. **Pratt M, Macera C, Blanton C:** Levels of physical activity and inactivity in children and adults in the United States: current evidence and research issues. Med Sci Sports Exerc 31 (1999) 526-533. doi:10.1097/00005768-199911001-00007
22. **Prätorius B, Milani TL:** Motorische Leistungsfähigkeit bei Kindern: Koordinations- und Gleichgewichtsfähigkeit: Untersuchungen des Leistungsgefälles zwischen Kindern mit verschiedenen Sozialisationsbedingungen. Dtsch Z Sportmed 55 (2004) 172-176.
23. **Reilly JJ, Jackson DM, Montgomery C, Kelly LA, Slater C, Grant S, Paton JY:** Total energy expenditure and physical activity in young Scottisch children: mixed longitudinal study: Lancet 363 (2004) 211-212. doi:10.1016/S0140-6736(03)15331-7
24. **Schenk, L, Ellert U, Neuhauser H:** Kinder und Jugendliche mit Migrationshintergrund in Deutschland. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 50 (2007) 590-599. doi:10.1007/s00103-007-0220-z
25. **Schilling F**: Körperkoordinationstest für Kinder: KTK. Beltz Test GmbH, Weinheim, 1974.
26. **Starker A, Lampert T, Worth A, Oberger J, Kahl H, Bös K:** Motorische Leistungsfähigkeit. Ergebnisse des Kinder- und Jugendgesundheitssurveys (KiGGS). Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz 50 (2007) 775-783. doi:10.1007/s00103-007-0240-8
27. **Wagner M, Jekauc D, Woll A, Bös K:** Einflussfaktoren der körperlich-sportlichen Aktivität, in: Bös K, Worth A, Opper E, Oberger J, Woll A (Hrsg.): Motorik-Modul.Eine Studie zur motorischen Leistungsfähigkeit und körperlich-sportlichen Aktivität von Kindern und Jugendlichen in Deutschland. Nomos Verlag, Baden-Baden, 2009, 237-256.
28. **Worth A, Opper E, Mess F, Woll A, Jekauc D, Bös K:** Motorische Leistungsfähigkeit, körperlich-sportliche Aktivität und Gesundheit von Kindern und Jugendlichen, in: Bös K, Worth A, Opper E, Oberger J, Woll A (Hrsg.): Motorik-Modul: Eine Studie zur motorischen Leistungsfähigkeit und körperlich-sportlichen Aktivität von Kindern und Jugendlichen in Deutschland. Nomos Verlag, Baden-Baden 2009, 16–41
29. **Worth A, Oberger J, Wagner M, Bös K:** Einflussfaktoren motorischer Leistungsfähigkeit, in: Bös K, Worth A, Opper E, Oberger J, Woll A (Hrsg.): Motorik-Modul. Eine Studie zur motorischen Leistungsfähigkeit und körperlich-sportlichen Aktivität von Kindern und Jugendlichen in Deutschland. Nomos Verlag, Baden-Baden 2009, 208-236.
30. **Zimmer R, Volkamer M:** MOT 4-6. Motoriktest für vier- bis sechsjährige Kinder. Manual. Beltz Verlag, Weinheim, 1987.
31. **Zimmer R:** Motorik und Persönlichkeitsentwicklung bei Kindern: eine empirische Studie zur Bedeutung der Bewegung für die kindliche Entwicklung. 2. Auflg. Hofmann Verlag, Schorndorf, 1996.

Corresponding Author
Klaus Greier, PhD
Pädagogische Hochschule – KPH Stams
Bewegungs- und Sporterziehung
Stiftshof 1
6422 Stams
Austria
E-Mail: klaus.greier@kph-es.at