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Evaluation of Motor Performance, Physical Activity and Health of Primary School Children - A Study Protocol (KOMPASS(2))

Beurteilung der motorischen Leistungsfähigkeit, körperlichen Aktivität und Gesundheit von Grundschulkindern – Ein Studienprotokoll (KOMPASS(2))

Summary

› **Background:** Physical activity is important for health at all ages, but many, including children, are not sufficiently active. Childhood physical inactivity is linked to deficits in motor skills, overweight, and obesity, with implications that extend into adulthood. Consequently, early intervention is crucial. However, addressing changes in family-influenced health behavior in primary school children challenges researchers. While cross-sectional studies on various determinants, e.g., family and built environment, on physical activity already exist, longitudinal data on these determinants and their associations are lacking, limiting the development of sustainable interventions. To investigate the associations between physical activity behavior, motor performance and health in primary school children the KOMPASS(2) study is being carried out.

› **Methods:** The study is based on a longitudinal panel since 2018, with data collected annually from primary school children. Data collection involves 1) a motor performance test, 2) anthropometric and clinical measurements and 3) a parent questionnaire on physical activity, media usage, family behavior, built environment and socio-demographic parameters.

› **Discussion:** The collected data provides an opportunity to investigate longitudinal interactions among individual circumstances, physical activity behavior, motor skills and medical parameters. The longitudinal design offers insights into trends and causal relationships over time, while comprehensive data collection methods facilitate a holistic view of determinants. Despite limitations such as panel mortality and self-report biases, the study's findings will inform the development of evidence-based interventions for promoting healthy lifestyles among children.

KEY WORDS:
Family, Built Environment, Media Use, Overweight Prevention, Sedentariness

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Introduction

Physical activity is vital for good health across all ages, with childhood physical activity linked to positive outcomes in healthy growth, psychosocial well-being, cognition, emotional functioning, and academic performance (2, 6, 9). However, a significant proportion of the population remains insufficiently active, with physical inactivity identified as a major 21st-century health problem (37).

Physical inactivity and sedentariness already appear in childhood. More than 75% of girls and more than 70% of boys in Germany aged 3 to 17 years do not reach the World Health Organization's (WHO) recommended minimum of an average of 60 minutes of moderate to vigorous physical activity per day (13). This lack of physical activity leads to deficits in motor performance (41) and a high prevalence of overweight and obesity (29). In contrast, results regarding correlations of such outcomes with sedentary behavior in children are inconsistent (1). Therefore, more research is needed. A closer look at the prevalence reveals that obesity manifests itself in childhood and continues into adulthood (29). This is evident from data identified through tracking (39).

In terms of physical activity tracking, results from a longitudinal study by Telama and colleagues (35) show that the stability of physical activity from adolescence to adulthood is moderate to high and that a physically active lifestyle begins to develop early in childhood. Furthermore, a tracking analysis of motor performance indicated that children, who exhibited motor disorders before school entry remained significantly behind children with no motor disorders in their motor development (32). Especially at the beginning of primary school, physical activity is still relatively high compared to the end of primary school with the onset of adolescence (12). Consequently, physical inactivity and sedentary behavior must be counteracted as early as childhood. For this purpose, additional longitudinal studies on physical activity and sedentary behavior around the age of school entry are required (24).

To bring about changes in everyday life, a more detailed analysis of the determinants influencing the health of children is necessary. For analyzing healthy behaviors, social-ecological approaches are considered to be particularly useful because they take into

account the interaction of personal and environmental factors (30). Regarding physical activity, Sallis et al. (27) developed a social-ecological model that identifies influences on individuals' physical activity behaviors in four domains of active living: recreation, transportation, occupation, and household. According to the model, physical activity is shaped by multiple levels of influence (including personal, sociocultural, environmental, sociopolitical) specific to each domain.

Against this background, the generic aim of this study is to contribute to a more detailed understanding of associations between physical activity behavior, motor performance, various influencing factors, and health in childhood over time, as well as to describe and explain mechanisms of action. To address these complex research objectives, an annual longitudinal survey throughout the years of primary school is implemented. Considering that motoric disorders affect motor development and physical activity, the study additionally aims to include and analyze data from schools' entry health examinations. Based on the analysis of those associations, recommendations for action and strategies for targeted and participatory interventions for children shall be developed.

Materials and Methods

The KOMPASS$_{(2)}$ study started with a 1st wave of data collection at Leipzig University from 2014 to 2018 (34), which has already provided us with various results (32). On this basis, a 2nd modified data collection wave with a more detailed questionnaire – related to a socio-ecological perspective – is been conducted since 2018, which is subject of this study protocol. Data collection is implemented annually at each grade level (1 to 4). The study is carried out in cooperation with the Saxon Education Agency of the State of Saxony/ Leipzig State Office, the Health Department of the City of Leipzig, and the Leipzig City Sports Association. An ethics vote was granted from the ethics committee of the Medical Faculty of Leipzig University (File number: 253-14-14072014).

Study Design

The study design corresponds to a panel survey, which is marked by the collection of data at several measurement points on the same sample. Each year, the examination of selected parameters such as motor, anthropometric and clinical parameters is carried out through different measurements. In addition, a parent questionnaire is used to collect data on physical activity and various influencing factors. All data collection methods are conducted once a year. The exception to this is the data collection in 2021. Due to the COVID-19 pandemic and the contact ban in place, as well as the lack of schooling in attendance, it was not possible to collect the motor performance data as well as anthropometric and clinical data in that year. Alternatively, the self-reported International Fitness Scale (IFIS) was applied (23).

Participants

The study includes primary school-aged boys and girls between 6 to 11 years. Places of study are primary schools in different districts of Leipzig. The schools are recruited based on previous school contacts and participation from wave 1. Sample selection is non-randomized and based on the interest and willingness of schools to participate in the study. In addition, written informed consent from parents regarding their child's participation is a requirement for study participation. Reasons for exclusion of the child were congenital or chronic cardiovascular diseases, acute infectious diseases, or acute injuries to the musculoskele-

tal system. Baseline sample at the 1st measurement point (1st grade) includes 543 children (m: 51%; w: 49%) who participated in all measurements. The average age of the sample is 7.4 years (SD=0.40). Data collection started in 2018/19 with 27 municipal primary schools in the city of Leipzig (N_1=609 children (questionnaire) and N_2=892 children (screening)) (figure 1).

Over the measurement time points, there is a reduction in sample size caused by the lack of schooling in attendance due to the COVID-19 pandemic and drop out. Dropouts can be explained by illness, relocation of the children and other reasons.

Measure and Instruments

The examination of selected parameters in the KOMPASS$_{(2)}$ study is based on three different measurements: 1) a motor performance test, 2) collection of anthropometric and clinical parameters and 3) a parent questionnaire on physical activity, media use, family behavior and built environment. In addition, data obtained externally from school entrance examinations through a social pediatric screening (SOPESS) (7) are incorporated into the study. In the KOMPASS$_{(2)}$ study, we combine these measurements to comprehensively capture the various aspects. The following section provides an overview of the various parameters that are collected.

Motor Performance Test

Motor skills are defined as ability to perform complex exercises quickly and accurately in continuously changing conditions (19). They are important to manage common physical tasks in daily life and being engaged in active leisure activities (18). By now, results of motor skills tests are used as a predictor or moderator for children's self-conceptualization, well-being as well as the development of physical activity, but also for tracking analyzes (14). However, test results show that stability of motor skills varies throughout the childhood (40).

The motor performance test, Deutscher Motorik-Test 6-18 (DMT 6-18), is used to assess motor skills (4). This includes eight test items: 20m sprint, balancing backwards, side jumps, 6-min run, stand and reach, push-ups, sit-ups, standing long jump. The test is performed following the instructions in the test manual. The validation process confirms the adherence of the DMT 6-18 to essential quality criteria (4, 38).
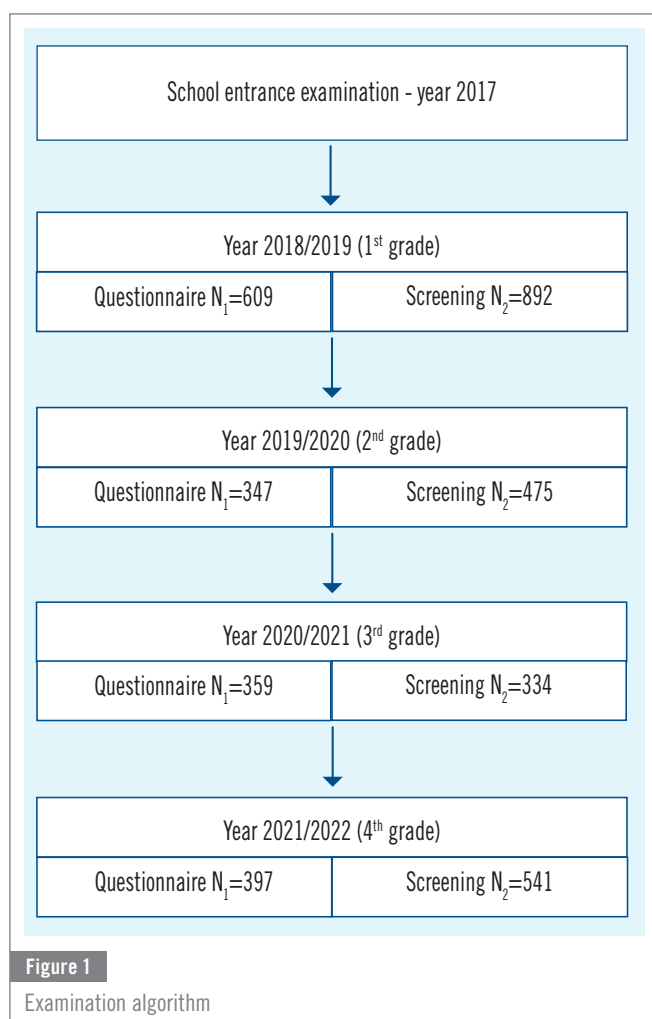
IFIS, used once instead of motor skills test because of COVID-19 pandemic, is a questionnaire that measures the subjectively perceived physical fitness level. This surveys a participant's general physical fitness, cardiorespiratory fitness, muscular strength, agility, and flexibility using five items (23). Except for coordination, IFIS consequently covers all dimensions of the concept of motor skills.

Anthropometric and Clinical Screening

Anthropometric and clinical parameters are collected to identify overweight or obese children and examine associations with lifestyle determinants and socioeconomic factors.

Anthropometric measurements of the children include body and seated height using a stadiometer. The Body-Mass-Index (BMI) and age and sex specific BMI-percentiles are calculated (17). Body mass and body fat percentage are measured using a digital SC 240 body composition monitor from Weightcheckers®. Circumferences of waist and hip are measured for calculating the waist-to-hip ratio using a flexible tape measure (maximum seat circumference, slimmest stomach-scope) (5).

As clinical parameters, systolic and diastolic blood pressure are measured manually (8). The measurement is taken while sitting after a rest period of about five minutes on the child's ❯

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│   School entrance examination - year 2017     │
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│         Year 2018/2019 (1st grade)            │
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│ Questionnaire N₁=609      │ Screening N₂=892   │
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│         Year 2019/2020 (2nd grade)            │
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│ Questionnaire N₁=347      │ Screening N₂=475   │
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│         Year 2020/2021 (3rd grade)            │
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│ Questionnaire N₁=359      │ Screening N₂=334   │
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│         Year 2021/2022 (4th grade)            │
├──────────────────────────┬────────────────────┤
│ Questionnaire N₁=397      │ Screening N₂=541   │
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Figure 1

Examination algorithm

right upper arm with an appropriate cuff. In addition, the heart rate is recorded electronically.

Parent Questionnaire

The parent questionnaire is designed to gather comprehensive information about the children's physical activity behavior as well as family and environmental influences. The questionnaire covers several main topics: Health status and physical activity, media usage behavior, family health behavior, built environment and socio-demographic parameters.

On the topic of health status and physical activity, a variety of data related to perceived health and, in particular, to the child's and parent's physical activity are collected. Because there is evidence that different domains play an important role in physical activity behavior (27), physical activity data are surveyed in the domains of daily leisure time, organized sports, employment/ school, and transport. The items are adopted from the German Health Interview and Examination Survey for Children and Adolescents' (KiGGS) (25), the associated 'Motorik-Modul study' (MoMo) (41), and the 'SAFARI-KIDS study' (22).

To assess the child's media usage behavior, the extent of the child's media usage on a regular day (Monday to Friday) and separately on the weekend is surveyed, including various media (smartphone, computer/ laptop, tablet PC, TV/ DVD, fixed game console, portable game console). In addition, the number of media devices in the household, the number of media devices owned by the child and whether their use is permitted in the child's room are recorded. The items are adapted from the KiGGS study (25) and are used in a modified form.

To map family health behavior influencing children's phys-

ical activity different items are included. To assess the importance of physical activity in everyday family life the Family Health Climate-Scale (FHC-S) for physical activity (21) is applied to collect data on physical activity values, behavior routines and interaction patterns within the family. Parents' beliefs in sport for good are determined by their agreement with various statements, are adopted from the Sport-for-Good scale (20) and related to beliefs in sports' capacity. A scale, developed following a previous study by Trost et al. (36) and Mutz and Albrecht (20), is used to assess parental support for the child's sports activities, including instrumental and emotional support.

Various factors of the built environment influencing physical activity are assessed using the parent questionnaire. Data are collected on housing situation (e.g., living space, household size, presence of garden and pets), type of housing in the immediate residential neighborhood, distance to and weekly use of nearby physical activity areas, such as parks, indoor swimming pools and playgrounds. In addition, parents are asked about the attractiveness, safety, amenities, and location of the residential environment for physical activity. These items were developed and are slightly modified following the validated European environmental questionnaire ALPHA (33).

Finally, socio-demographic parameters are recorded. Data on family size, marital status, parents' level of school education, parents' highest level of occupational education completed, and parents' occupational status are collected following Ehling et al. (11). Additionally, the collection of data regarding nationality and migration background is carried out in accordance with the guidelines outlined by Schenk et al. (28). The inclusion of these sociodemographic parameters is intended to provide a comprehensive understanding of the participants' family background and socioeconomic status, which will enrich the overall analysis and interpretation of the study's findings.

Assessing Developmental Stages in Preschool Children

A social pediatric screening for school entry examination (SOPESS) (7) serves to assess the developmental stage of preschool children. The test involves measuring six dimensions of children's health-related developmental status. Two motor skills (visual-motor coordination, gross motor coordination), three cognitive-related skills and language skills are assessed. A standardized score is available for each subtest of the developmental dimensions. With the help of percentile values, the results can be divided into three development categories with the designations "remark", "minor", "unremarkable". Finally, it allows the developmental stages of children to be assessed in a health context.

Collection of Data and Analysis

Motor skills testing and the collection of anthropometric and clinical data is conducted directly in the schools. At the same time, the questionnaires are being send out by mail to the schools and distributed among participating children. The completed questionnaires are collected by schools and sent back to the institute. The completion of the questionnaire is undertaken by the children's parents in paper-pencil format. Data collection is processed pseudonymized.

For the implementation of the motor performance, anthropometric and clinical tests, test administrators and test assistants are recruited from Leipzig University. Data is documented handwritten on standardized test sheets by trained test administrators. All collected data is entered in a purpose-built data-

base. Data entry follows a stringent codebook. After finishing all data collection and entry processes, plausibility checks are conducted, and input errors corrected. Unclear information, e.g., dual crosses, are corrected following a specific data control concept orientated on Jekauc et al. (16). A strategy for dealing with missing data will be developed. Every correction made in the raw database is completely documented in an extensive protocol. In order to control disruptive factors such as variation of the test location, temporal variation of the measurement data, variation of the participants' clothing (e.g. shoes), these are well documented on the test sheets and as notes in the raw database and must be taken into account in analyses.

The data analysis strategy is explorative in relation to the main research question. Descriptive statistics and hypothesis-testing statistical methods will be performed using SPSS statistical software version 29.

Discussion

Promoting physical activity and fitness as well as reducing sedentary lifestyle in childhood is a key factor in health promotion and prevention of lifestyle-related diseases (15, 3). The KOMPASS$_{(2)}$ study generates data to analyze interactions between physical activity behavior, health, and motor skills, taking into account family and environmental factors. These analyses will lead to the development of strategies and interventions for health promotion in primary school-aged children. Those are needed for healthy development, for counteracting the increased time of inactivity caused, among other factors, by recent technological advances and for helping to prevent inactivity and sedentariness associated morbidities, such as obesity. As childhood obesity is linked to lifelong medical, psychological, social, and socio-economic disadvantages, this is of high relevance (29).

Regarding the strengths and limitations of the KOMPASS$_{(2)}$ study, the following should be pointed out. A major strength of the study is its longitudinal panel design. This design enables the examination of changes and trends over time, as well as insights into causal relationships. The examination of changes and trends over time, e.g., in motor performance, is particularly interesting against the background of the COVID-19 pandemic prevailing from the second measurement time point. In addition, due to its design, the KOMPASS$_{(2)}$ study provides a data basis for comparing the results with other national health surveys particularly in the development of motor skills, physical activity behavior and health as well as selected determinants. Moreover, we plan to compare the results of the 2nd wave with the results of the initial data collection wave of the study in order to identify potential differences in various variables, e.g. children's participation in organized sport, between the different measurement periods. A challenge in panel studies, however, is the so-called panel mortality, which is characterized by the progressive loss of participants due to various causes (illness, relocation, etc.) during the measurement points (10). Panel mortality is evident in the ongoing study by the decline in the number of participants, which was further reinforced by the COVID-19 pandemic prevailing from the second measurement time point. To address this issue of panel mortality, we will implement statistical methods to account for missing data and conduct sensitivity analyses to assess the potential impact of attrition on the results.

This comprehensive approach, which employs a wide range of measurement methods, is intended to contribute to a holistic understanding of the factors influencing children's de-velopment of motor skills, health, and physical activity and to enable tracking analyses. In addition, the use of validated instruments, such as the DMT 6-18 (4) and adapted items from the KiGGS study (25), ensures the reliability and validity of the collected data.

All data collected in the present KOMPASS$_{(2)}$ study refer to the urban area Leipzig. Because of the study's focus on primary school children in this specific geographic region, the generalizability of findings to other populations or age groups may be limited. In the future, however, an expansion to the entire state of Saxony would be a possibility to achieve greater representativeness. This would also require generating data from rural areas.

Furthermore, we must point out general existing limitations of a questionnaire survey. Some data, such as physical activity and media usage, were collected through parent-reported questionnaires, introducing the possibility of self-report bias. Social desirability or recall bias may influence the accuracy of these responses (26). In contrast to objective methods for assessing physical activity, which are always limited to a short time interval, self-report assessments offer insights into long-term behavior patterns. Questionnaires provide information about overall engagement in physical activity with the chance to assess different types of exercise over extended periods, which is crucial for understanding habitual activity levels and behavioral trends (31).

Finally, based on panel analysis, the KOMPASS$_{(2)}$ study holds promise for enhancing our understanding of the development and the complex interactions between physical activity behavior, motor skills, and health in primary school children. The findings will be valuable for informing policies aimed at promoting healthy lifestyles in this critical age group. Moreover, the results are intended to support an interprofessional approach involving different stakeholders in the development of evidence-based tailored interventions. ■

Summary Box

Physical inactivity levels are emerging, not only in adults but in children and adolescents as well. The purpose of this study is to analyze the development of motor skills, physical activity, and health, as well as their determinants and interactions, in primary school children.

The study is based on a longitudinal panel since 2018, with data collected annually from primary school children in Leipzig. The study does not only survey motoric data through the DMT 6–18 and health-related data through anthropometric and clinical tests, but also looks at the given background information through a parent's questionnaire. In the following, the methodical structure of the second wave of the KOMPASS(2) study is described

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