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COHORT PROFILE

Cohort Profile: The Motorik-Modul Longitudinal Study: physical fitness and physical activity as determinants of health development in German children and adolescents

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The Motorik-Modul (MoMo) Longitudinal Study aims to contribute to long-term improvement in the health of German children and adolescents by focusing on: (i) the development of physical fitness and physical activity (including period effects); (ii) the individual and physical/social environmental determinants of the development of physical fitness and physical activity; and (iii) the impact of physical fitness and physical activity on the development of physical and mental health. The MoMo Longitudinal Study began with a nationwide representative sample of 4529 children and adolescents who ranged in age from 4–17 years at the study baseline (2003–2006). The first survey wave of the MoMo Longitudinal Study was conducted between 2009 and 2012, with two subsequent survey waves to be conducted between 2014 and 2016 and 2018 and 2020, respectively. The MoMo Longitudinal Study includes a physical fitness test profile, a physical activity questionnaire, and subjective and objective measures of health from the German Health Interview and Examination Survey (KiGGS). Data access is provided on request (alexander.woll@kit.edu). For further information, including a complete list of publications please visit www.motorik-modul.de.

Keywords Longitudinal studies, physical fitness, motor activity, health, cohort effect

Why was the cohort set up?

The health status of German children and adolescents had not been sufficiently studied by the end of the twentieth century. To remedy this situation, the nationwide German Health Interview and Examination Survey for Children and Adolescents (KiGGS; www.kiggs.de) was conducted by the Robert Koch-Institute (RKI, Berlin) between 2003 and 2006 (KiGGS Baseline Study).[1] The KiGGS Baseline Study included a core survey and five modular in-depth studies

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conducted with corresponding KiGGS subsamples. One of those modular studies, the Motorik-Modul (MoMo) Baseline Study, was conducted by the University of Karlsruhe and provided nationwide representative data on the physical fitness and physical activity status of German children and adolescents. Results of the MoMo Baseline Study have been published in several consecutive research papers.[2–8]

The MoMo Baseline Study continued longitudinally in 2009 as a joint project of the University of Konstanz, the Karlsruhe Institute of Technology, and the University of Education Karlsruhe, in parallel with the longitudinal continuation of the KiGGS Baseline Study.[9] The sub-sample structure of the KiGGS study was maintained so that each member of the MoMo cohort also belongs to the KiGGS cohort. The primary goal of the MoMo Longitudinal Study is to contribute to long-term improvement in the health of German children and adolescents; it was set up to address the following research topics:

(i) The development of physical fitness and physical activity (including period effects).
(ii) The individual and physical/social environmental determinants of the development of physical fitness and physical activity.
(iii) The impact of physical fitness and physical activity on the development of physical and mental health.

Who is in the cohort?

In the KiGGS Baseline Study, the RKI sought to obtain a study sample representative of children and adolescents with primary residence in Germany. Thus, the RKI and the Centre for Surveys, Methods and Analysis (GESIS, formerly ZUMA) used a stratified multi-stage probability sample with three evaluation levels. First, a systematic sample of 167 primary sampling units was selected from an inventory of German communities.[1] Second, an age-stratified sample of randomly selected children and adolescents, with a total of 17 641 participants aged 0–17 years, was drawn from the official registers of local residents.[10] Third, 7866 children and adolescents in the KiGGS baseline sample, ranging in age from 4–17 years, were randomly assigned to the MoMo baseline sample. Of these 7866 children and adolescents, 4529 finally participated in the MoMo Baseline Study (response rate 57.6%). The comparison of participants in the MoMo Baseline Study with non-responders found the typical and expected differences in terms of socioeconomic status and migration background (Table 1). Participants in the KiGGS Baseline Study without a migration background and of middle socioeconomic status had a higher probability of participating in the MoMo Baseline Study. Body mass index (BMI) did not contribute to the prediction of participation. To improve the representativeness of the study results, deviations of the study sample from the general population in terms of age, sex, region, and country of citizenship were corrected by weighing the data.[10] Depending on the pattern of missing data, different methods were used for this (e.g. listwise deletion, multiple imputation, full information maximum likelihood).

How often have they been followed up?

The MoMo Longitudinal Study includes a longitudinal sample (LS) as well as four cross-sectional (CS) samples (Figure 1).

The first survey wave of the MoMo Longitudinal Study, covering 167 primary sampling units (communities), began in September 2009 and ended in July 2012. The longitudinal sample in the first survey wave included 2178 participants aged 10–23 years, which constitutes an overall response rate of 48.1%. For 664 participants in the longitudinal sample who were unable to appear for testing on any of the test dates, physical activity as a minimum variable was assessed by questionnaire, which raised the total longitudinal sample size to 2842 participants, corresponding to a response rate of 62.8% (Table 2). In addition, 2317 participants ranging from 4–17 years of age who did not participate in the MoMo Baseline Study were recruited from the KiGGS baseline sample for the identification of period effects in physical fitness and physical activity (Table 2: cross-sectional sample).

Data on the nature of attrition as well as on the representativeness of the cross-sectional refreshment sample are not yet available, but will be provided after data cleansing. Publication of results of the first survey wave is planned for the end of 2013. On the basis of the first survey wave, the MoMo Longitudinal Study will be continued in the second wave (wave 2), between 2014 and 2016, and in the third wave (wave 3) between 2018 and 2020, respectively. As in the first survey wave, the longitudinal sample will be supplemented by equivalently aged participants in every consecutive survey wave.

What has been measured?

Physical fitness and physical activity, as well as corresponding individual and physical/social environmental determinants, were assessed in the MoMo Longitudinal Study. Health-related data, as well as corresponding individual and physical/social environmental determinants were assessed in the KiGGS Longitudinal Study. However, due to the the subsample structure, every member of the MoMo cohort also belongs to the KiGGS cohort, allowing the two studies' data sets to be merged. A comprehensive list of concepts and measurements is presented in Table 3.

The MoMo Longitudinal Study included a physical-fitness test profile as well as a physical activity questionnaire (MoMo-PAQ). Physical fitness tests

Table 1 Response-Nonresponse comparison for the MoMo Baseline Study

Predictor		Girls			Boys		
		4–5 years *M [CI]*	6–10 years *M [CI]*	11–17 years *M [CI]*	4–5 years *M [CI]*	6–10 years *M [CI]*	11–17 years *M [CI]*
BMI	Nonresp.	15.8 [15.5-16.1]	17.1 [16.8-17.4]	21.4 [21.1-21.7]	15.7 [15.5-15.8]	17.1 [16.9-17.4]	21.3 [20.9-21.6]
	MoMo	15.6 [15.5-15.8]	16.8 [16.7-17.0]	20.8 [20.5-21.1]	15.7 [15.6-15.9]	16.9 [16.7-17.0]	20.5 [20.2-20.7]
		freq. in % [CI]	*freq. in % [CI]*	*freq. in % [CI]*	*freq. in % [CI]*	*freq. in % [CI]*	*freq. in % [CI]*
Migration background	Nonresp.	10.2 [6.1-14.4]	12.7 [9.6-15.9]	9.1 [6.7-11.5]	10.8 [6.8-14.8]	13.3 [10.1-16.6]	11.0 [8.4-13.6]
	MoMo	4.6 [2.7-6.4]	7.4 [5.7-9.2]	6.0 [4.4-7.5]	6.4 [4.2-8.6]	5.9 [4.3-7.5]	5.2 [3.8-6.6]
Socioeconomic status	high	Nonresp.	33.5 [27.0-40.0]	27.2 [22.9-31.5]	27.2 [23.4-31.0]	26.0 [20.3-31.6]	27.5 [23.2-31.8]	20.9 [17.4-24.3]
		MoMo	26.1 [22.3-29.9]	26.3 [23.3-29.3]	23.6 [20.8-26.4]	25.3 [21.4-29.2]	26.3 [23.4-29.3]	24.0 [21.2-26.8]
	middle	Nonresp.	39.0 [32.2-45.8]	42.0 [37.2-46.8]	47.1 [42.9-51.4]	42.3 [36.1-48.8]	36.8 [32.1-41.4]	48.2 [43.9-52.5]
		MoMo	48.6 [44.2-53.0]	49.1 [45.7-52.5]	48.5 [45.2-51.8]	47.1 [42.7-51.7]	48.4 [45.1-51.8]	51.1 [47.9-54.4]
	low	Nonresp.	27.5 [21.3-33.7]	30.8 [26.4-35.3]	25.7 [21.9-29.4]	31.7 [25.6-37.6]	35.7 [31.1-40.4]	30.9 [27.0-34.9]
		MoMo	25.3 [21.5-29.1]	24.6 [21.7-27.5]	27.9 [25.0-30.9]	27.6 [23.6-31.6]	25.3 [22.4-28.2]	24.9 [22.1-27.7]

Note. M, Mean; CI, 95% confidence interval; freq. %, relative frequency in percent; Nonresp., Nonresponder.

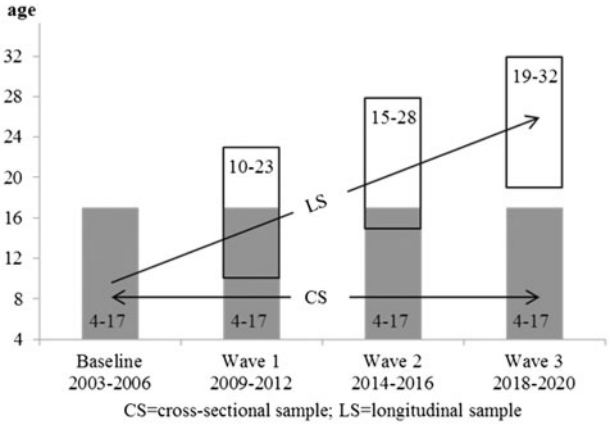

Figure 1 Design of the MoMo Longitudinal Study

Table 2 Sample structure of the first wave of the MoMo Longitudinal Study

Age	Sex	Longitudinal sample		Cross-sectional sample	
		N	%	*N*	%
4–5 years	Male	0	0.00	207	8.93
	Female	0	0.00	200	8.63
6–10 years	Male	105	3.69	674	29.09
	Female	138	4.86	671	28.96
11–17 years	Male	859	30.23	278	12.00
	Female	876	30.82	287	12.39
⩾ 18 years	Male	411	14.46	0	00.00
	Female	453	15.94	0	00.00
Total		2842	100.00	2317	100.00

were selected in a way that participants of all ages could accomplish them. Although most of the tests were adapted from common test batteries, such as the Körperkoordinationstest,[37] the assessment of cardiorespiratory fitness was based on a specific protocol. Cardiorespiratory fitness was assessed with the Physical Working Capacity 170 (PWC170) cycle ergometry test (attained watts at 170 beats/min) on an ERG 911S (Ergosana, Bitz, Germany) bicycle. Initial workload was calculated as 0.5 watts/kg body mass. The workload was increased incrementally by 0.5 watts/kg body mass every 2 minutes. Subjects continued this progressive protocol until their heart rate exceeded 190 beats/min for at least 15 seconds, or their pedaling rate was less than 50 revolutions per minute for at least 20 seconds, or until they decided to stop because of exhaustion. Heart rate (HR) was measured with a chest-strap T31 monitor (Polar Electro Oy, Kempele, Finland) immediately before each increase in workload. The HR signal was transmitted to the bicycle ergometer. The power in watts generated by a subject at a heart rate of 170 beats/min

Table 3 Concepts and measurements used in the MoMo Longitudinal Study

Concept	Measurements
Physical fitness	Physical-fitness test profile: endurance (cardiorespiratory fitness), strength (upper and lower limb), gross motor coordination (dynamic and static balance), fine motor coordination (manual dexterity, reaction time), flexibility (trunk).[7,8]
Physical activity	Self-/proxy-report questionnaire: overall physical activity (in the past 7 days and in a normal week), everyday physical activity (duration, frequency, type), sports activity at school as well as in and outside organized clubs (duration, frequency, intensity, type, seasonality),[11] hours of computer use or television viewing.[12]
Health	Physical examinations and tests: obesity (body mass index, waist and hip circumference, waistline, skin-fold thickness, diagnostic questions, total body fat), cardiovascular risk factors (blood pressure, blood lipids, insulin, glucose).[13–17]
	Standardized medical interview: chronic diseases (bronchitis, atopic dermatitis, hay fever, asthma) and pain (head, back, stomach, abdomen, thorax).[18,19]
	Self-/proxy-report questionnaires: hyperkinetic disorder[a] (hyperactivity/inattention), soft skills/social competence (pro-social behaviour), resources for mental development (familiar protective factors, personal protective factors, social resources), quality of life (physical and mental well-being, well-being in the family, peer and daily life context).[21–27]
Individual determinants	Self-/proxy-report questionnaires: age (chronological), sex, enjoyment of physical activity, self-concept (self-worth, perceived competence).[28–32]
Physical/social environmental determinants	Self-/proxy-report questionnaires: socioeconomic status (educational/professional status, total income of the family household), migration background (nationality, country of birth, year of immigration), residential area (rural, small town, medium-size town, city), environmental support for physical activity (physical and social environment).[12,33–36]

[a]The term Hyperkinetic disorders defines 'A group of disorders characterized by an early onset (usually in the first five years of life), lack of persistence in activities that require cognitive involvement, and a tendency to move from one activity to another without completing any one, together with disorganized, ill-regulated, and excessive activity.'[20]

(PWC170) was obtained by the monitoring investigator's inter- or extrapolating the measured data in Microsoft Excel.

The MoMo-PAQ was designed as a self-/proxy-report questionnaire and completed by parents and children (4–10 years of age), adolescents (11–17 years of age), or adults (18 years of age and older), respectively. The completion of both the physical fitness test profile and the MoMo-PAQ took between 70–90 minutes.

The MoMo data base is linked to selected geographical and contextual socioeconomic variables of the Indikatoren und Karten zur Raumentwicklung (INKAR) data base, which is provided by the German Federal Office for Building and Regional Planning and contains a wide range of regional variables (e.g. employment, levels of education, production, and wages).[38]

The KiGGS Baseline Study included questionnaires filled in by parents (for children between 0–10 years of age) and parallel questionnaires for adolescents of the age of 11 years onwards, physical examinations and tests, and a computer-assisted personal interview (CAPI) conducted by a physician. Testing of blood and urine samples was done at central laboratories. Consecutive KiGGS survey waves include varying assessment methods (e.g. telephone interview) and are described elsewhere.[9]

What has it found? Key findings and publications

Results of the first survey wave of the MoMo Longitudinal Study are expected at the end of 2013. Hence, the main results to date of the MoMo Baseline Study are summarized below:

(i) Cardiorespiratory fitness increases during childhood with a sex-specific differentiation in favour of boys at the onset of puberty (see Figure 2).[7]

(ii) Overweight and obese boys and girls show lower levels of physical fitness than boys and girls of normal weight.[8]

(iii) Seventeen percent of boys and 13% of girls meet the World Health Organisation (WHO) physical activity guideline[39] for children and adolescents, of 60 minutes of moderate-to-vigorous physical activity daily. The steepest decrease in compliance with the guideline is observed for age groups close to the transition from primary (6–10 years of age) to secondary (11–13 years of age) school (see Figure 3).[2]

(iv) Girls of low socioeconomic status or with a migration background and boys living in rural

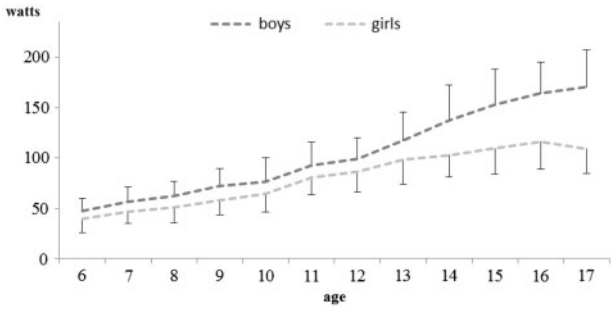

Figure 2 Cardiorespiratory fitness in the MoMo Baseline Study

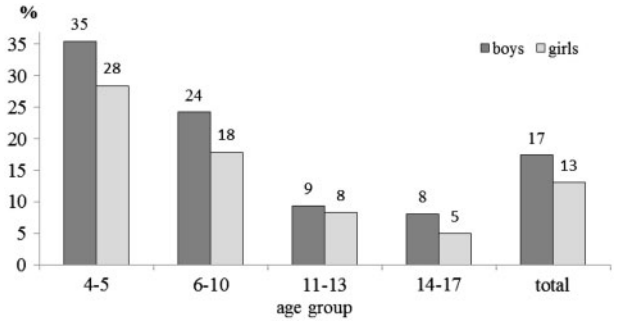

Figure 3 Physical activity guideline compliance in the MoMo Baseline Study

areas have the lowest likelihood of complying with the WHO physical activity guideline.[2,39]

(v) Health-related factors such as normal weight, time spent in sports-club activity, leisure-time physical activity, and active commuting to school by bicycle are positively linked to adolescents' cardiorespiratory fitness.[3]

(vi) Being physically active, especially in sports clubs, is positively linked to a higher health-related quality of life.[5]

A complete list of publications is provided via www.motorik-modul.de

What are the main strengths and weaknesses?

The MoMo Longitudinal Study offers a unique opportunity to: (i) assess the physical fitness and physical activity status of German children and adolescents aged 4–17 years on a nationwide representative basis; and (ii) study the development of physical fitness and physical activity (including period effects) and their individual and physical/social environmental determinants. Furthermore, the compatibility of MoMo and KiGGS data permits analysis of the impact of physical fitness and physical activity on the development of physical and mental health. The MoMo Longitudinal Study is therefore expected to make an important contribution to theory and model formation in research on child and adolescent health.

However, the response rate during the initial phase of the MoMo Longitudinal Study (wave 1) was lower than expected. In the meanwhile, options for improving the response rate (e.g. improvement of incentive concept, additional test days) have been discussed and implemented. Furthermore, the long time span between the measurement points leads to an increase in uncertainty and wider confidence intervals for development trajectories. Additionally, several constructs (e.g. physical activity) were measured with subjective methods (e.g. questionnaire) and should prospectively be complemented by objective data (e.g. accelerometry).

Can I get hold of the data? Where can I find out more?

Data collected in the MoMo Longitudinal Study are available on request (alexander.woll@kit.edu). For further information please visit www.motorik-modul.de.

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Conflict of interest: None declared.

KEY MESSAGES

- Cardiorespiratory fitness increases during childhood with a sex-specific differentiation in favour of boys at the onset of puberty.
- Girls of low socioeconomic status or with a migration background and boys living in rural areas have the lowest likelihood of being physically active.
- Being physically active, especially in sports clubs, is positively linked to a higher health-related quality of life.

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