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Post-Pandemic Covid-19 Recovery of Physical Fitness in Third-Grade of Primary School

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Thuringia Team @ Uni Erfurt: **Florian Bähr (PI)**, Toni Wöhrl, Paula Teich, Reinhold Kliegl

Meeting of Youth Global Fitness Consortium 2025-09-03

1. I will talk about two projects from German states -- one from Brandenburg, the other one from Thuringia.

EMOTIKON Test Battery

Endurance ⊳
6-minute run

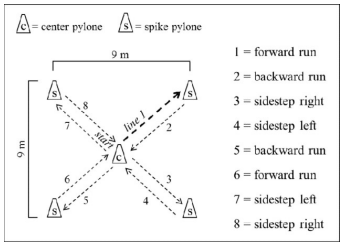
Coordination w/ time pressure ⊳ Star run

Speed ⊳
20-m sprint

PowerLOW ⊳
Standing long jump

PowerUP ⊳
Ball push task

Balance ⊳
One-legged stance



In the state of **Brandenburg** since 2009 annual assessment of 3rd–grade primary school children by sports teachers (N ≈ 280 000 children; 2016–2024: N ≈ 123 000 keyage children; i.e., enrollment according to legal key date)

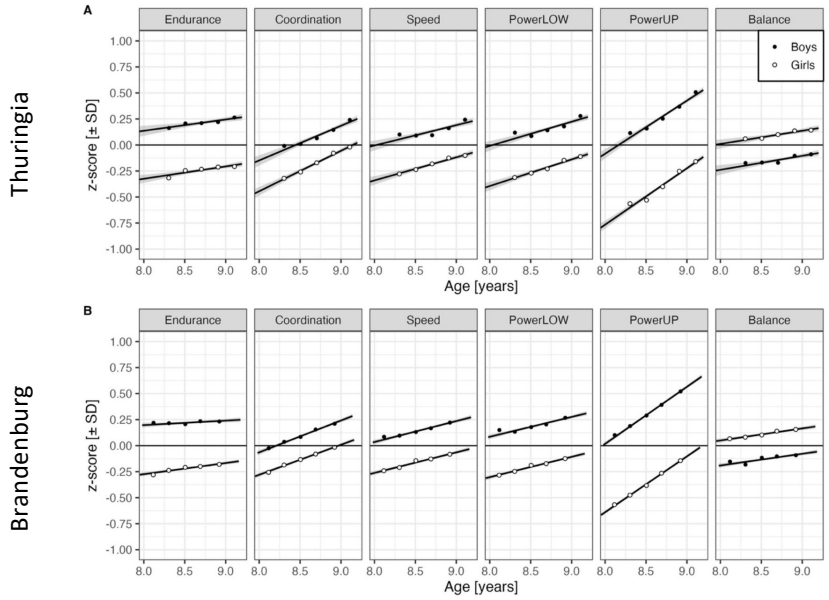
In the state of **Thuringia** since 2017 annual assessment of 3rd–grade primary school children by sports teachers; mandatory since 2022 (N ≈ 66 000 children; 2017–2024: N ≈ 54 000 keyage children)

https://www.uni-potsdam.de/de/emotikon/projekt/methodik.html

2. Both projects use the EMOTIKON test. Data are collected by sports teachers every fall. The items are self-explanatory - with exception of the star run. Here the children run a complex pattern of forward, backward and sideward movements as fast as possible. Note that we converted scores for star run and 20-m sprint to speed. Therefore, for all tasks larger values reflect higher fitness.

I report results from about 123 K Brandenburg children from the 2016 to 2024 cohorts; they were all between 8 and 9 years old. My results from Thuringia are from a similarly selected set of around 54 K children.

Thuringia: 2017 – 2023 Cohorts; Brandenburg: 2016 – 2023 Cohorts



EMOTIKON Test

- **6-minute run**
- **Star run**
- **20-meter sprint**
- **Standing long jump**
- **Ball push test**
- **One-legged stance**

Bähr, Wöhrl, Teich, Puta, & Kliegl (2025)

3. This is one of our key results. We observed parallel development for boys and girls in all tasks. None of the sex x age interactions is significant -- despite huge samples. We think, in this case, absence of evidence is evidence of absence, because we also closely replicated the pattern across the two states.

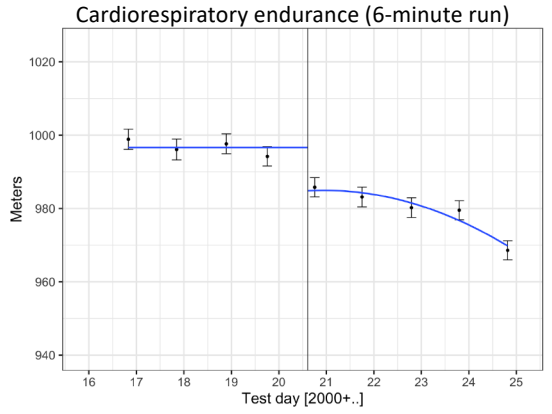
Effects of Brandenburg-Region x Covid-19 Pandemic on Physical Fitness

Far from Berlin | Close to Berlin

- Are ”fitter” schools close to Berlin?
- School Social Index == Social Burden 1–4 based on:
  1. SGB-II rate (≈ socio-economic status)
  2. % non-native language
  3. % special educational needs
- Task-specific Covid-19 pandemic impact on children’s physical fitness?
- Does the Covid-19 impact vary with social burden?
- **Regression discontinuity design (RDD)**
  (Thistlethwaite & Campbell, 1960)

4. In Brandenburg we are in a good position to check how social structure has moderated Covid-pandemic effects because the belt around Berlin is socio-economically much better off than regions far from Berlin. We also have an official school social index capturing such differences very well. It is a composite of socio-economic status, the percentage of children with non-native language, and the percentage of children with special educational needs. The four levels are quartiles. With respect to Covid-pandemic effects, the challenge is to assess them against secular trends. We used a regression discontinuity design to test this.

Regression Discontinuity Design



Testing pandemic effects at 1st day of school in school year 2020/21 (i.e., critical date = CD)

Test day (TD) centered @ CD

Covid-19 = if_else (TD <= 0, 0, 1)
=> estimates change in performance @ critical date

Covid-19 x TD

=> estimates change in slope @ critical date

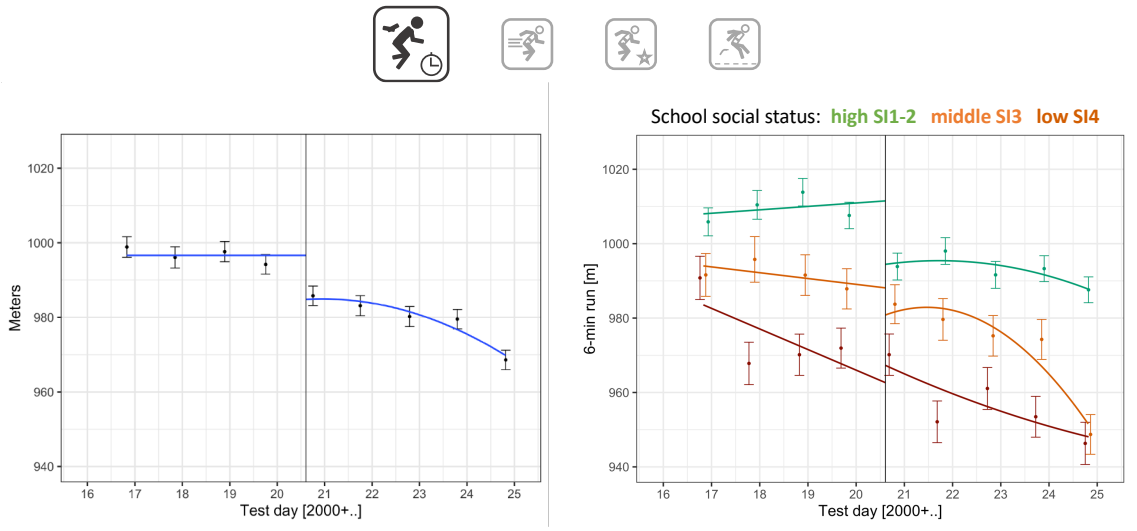
Inference
Statistical adjustment for sex, age, and secular trends implemented in linear mixed model with random factors for child and school in Julia MixedModels.jl

Estimates are **quasi-experimental** (i.e., not causal!), but strongly indicative of Covid-19 pandemic effects.

Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

5. We specified the first day of school for the 2020/21-cohort as the critical date -- the vertical line in the figure, -- and estimate two Covid effects: the difference between the two secular trends at the critical date and the change between them. The graph shows our results for the 6-minute run with 95% CIs. There is strong evidence for both effects, but, unfortunately, at least so far, there is no evidence for a rebound – rather the opposite. Let's break this overall trend down by school social status.

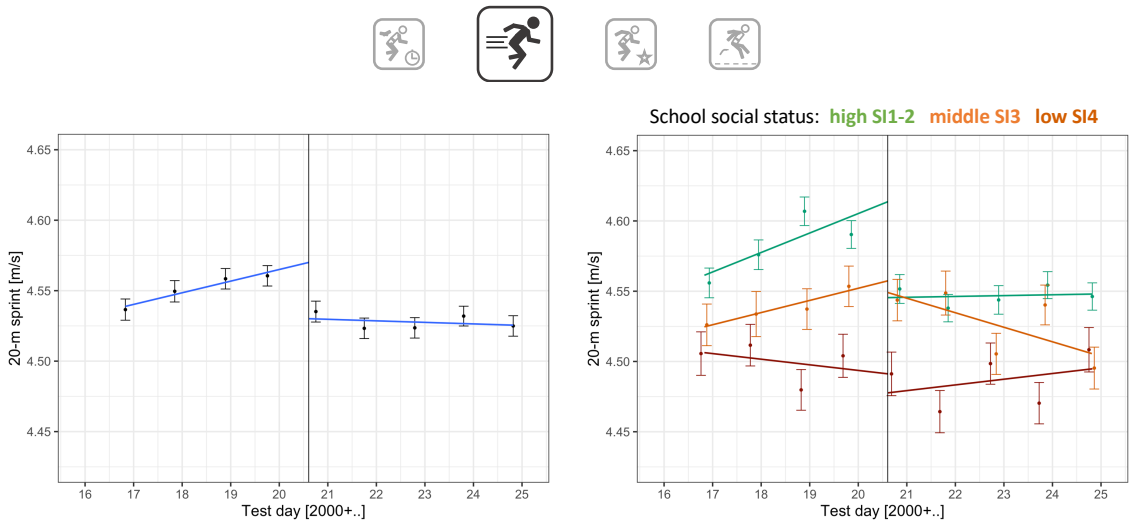
Cardiorespiratory Endurance (6-min run): Cohort/Covid x School Social Status



Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

6. In endurance, across all years, children in high-SES schools have run further. Before Covid, the difference even increased. The Covid pandemic, however, affected high-SES schools much more. The simple conclusion is that children living in well-to-do regions, for example, around Berlin, had more to lose when Covid-related restrictions were imposed. I was quite surprised by this result. Unfortunately, it looks like there are also delayed negative effects for low-SES schools.

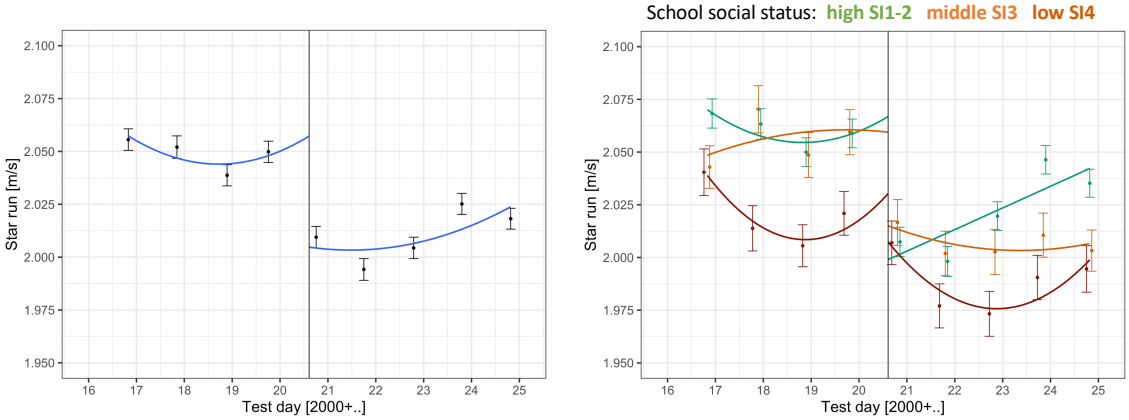
Speed (20-m sprint): Cohort/Covid x School Social Status



Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

7. A very similar pattern of results is found for the 20-m-sprint.

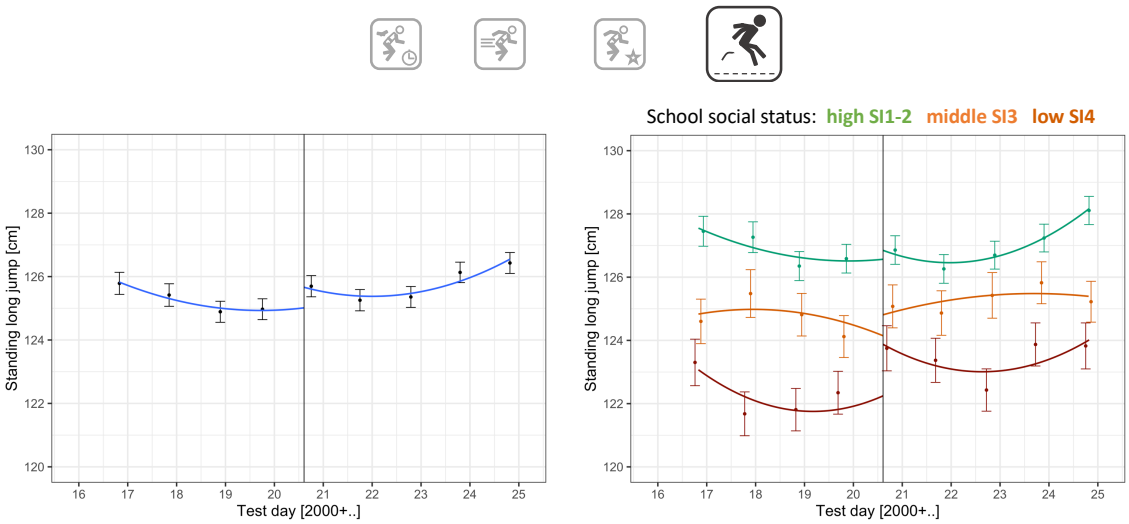
Coordination (star-run): Cohort/Covid x School Social Status



Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

8. And the effect of school social status was even more pronounced for the star run. In the fall of 2020, the difference between schools of different social status was eliminated. Now, there is evidence for faster recovery for high-SES schools. The old order gets re-established.

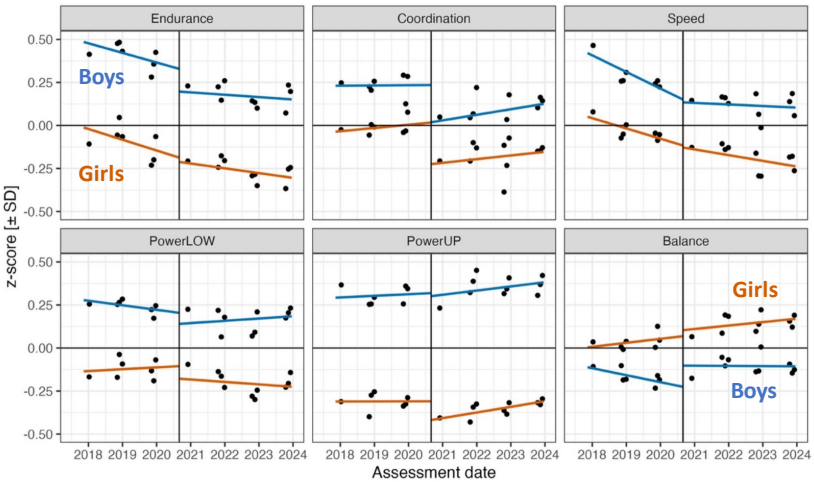
PowerLOW (standing long jump): Cohort/Covid x School Social Status



Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

9. We did not observe significant Covid-pandemic related effects for standing long jump.

Thuringia: „Bewegte Kinder, gesündere Kinder“ 2016–2023 (N = 38,084 children)

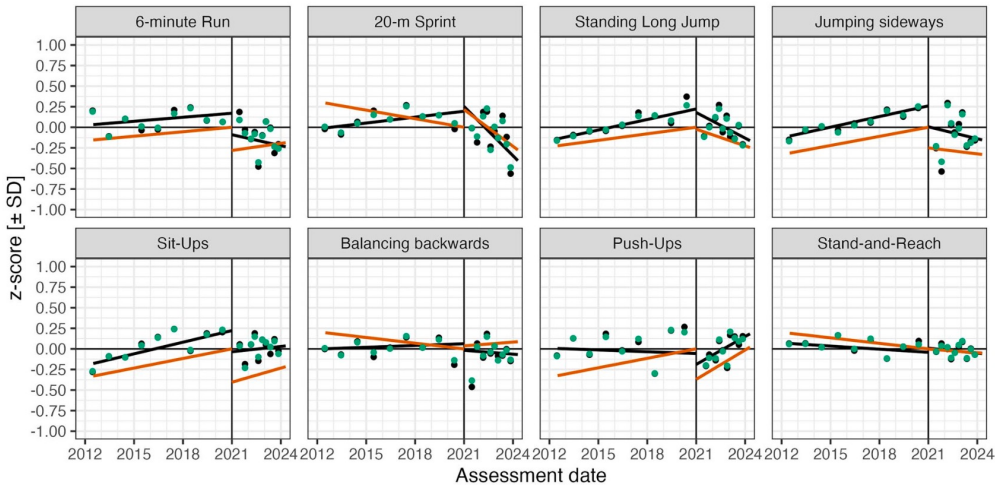


https://doi.org/10.1038/s41598-025-95461-5

Bähr, Wöhrl, Teich, Puta, & Kliegl (2025)

10. In Thuringia, we found the negative effect on endurance only for boys. We replicated the Brandenburg results for coordination, but not for speed – presumably because of the strong negative pre-pandemic trend here. Different from Brandenburg, however, there was a significant effect for standing long jump. And like in BB, there was also a strong rebound for coordination in 2024 (not shown here) and not much evidence for it in the other tasks.

Baden-Württemberg: Fitnessbarometer 2012–2023 (N=25,580; age: 6-10 years)



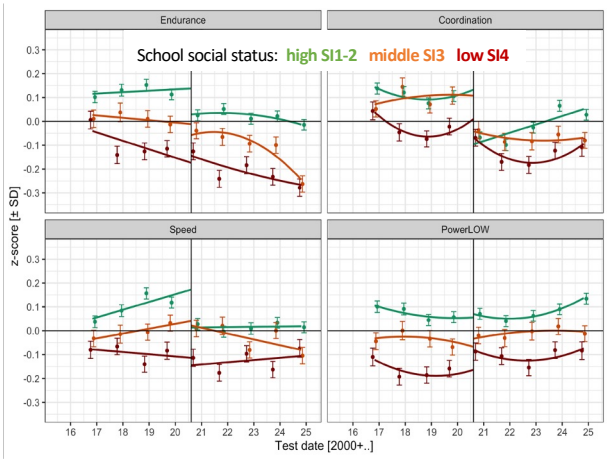
Legend: **zero-order fits and means;** corresponding LMM-fitted means;
partial fixed effects (controlling for age, sex, secular trends, body constitution,…)

Eberhardt, Bös, Woll, Kliegl, & Niessner (2025;)

https://doi.org/10.1186/s40798-025-00881-2

11. We also cooperated with Tanja Eberhardt and Claudia Niessner on a project, using tasks from the German Motor Test. Here we observed Covid pandemic effects for six items: 6 min run, jumping sideways, sit-ups, push-ups, 20 m sprint, and standing long jump with the last one replicating the result from Thuringia.

Physical Fitness Component x Cohort/Covid x School Social Status



- There were small, but reliable Covid-19 effects in running tasks in three German federal states (Brandenburg, Thuringia,, Baden-Württemberg), for standing long jump in TH and BW (+ other tasks)
- Negative effects on running wee especially large in schools of high socioeconomic status in BB;
- The reverse Matthew effect underlines relevance of socio-structural environment for children's fitness
- As of fall 2024, there was only evidence of rebound only for coordination in TH and BB (mostly high-SES)
- No evidence for rebound of endurance and speed => serious **long-term consequences** of pandemic?

Teich, Arntz, Wöhrl, Bähr, Golle & Kliegl (2025) + Data from 2024

12. Let me summarize. There were small, but reliable Covid-pandemic effects in running tasks in three German federal states; there is also evidence for standing long jump in TH and BW. In BW also for other tasks of the German Motor Test.

+ In Brandenburg, negative effects on running were especially large in high-SES schools. This result underlines the relevance of socio-structural environment for children's fitness. Note also that there is the usual Matthew effect for children with educational risks; they were more affected by Covid.

+ As of fall 2024, there was clear evidence of rebound primarily for coordination in TH and BB and in BB mostly for high-SES schools.

+ So far there is no evidence for rebounds of endurance and speed => this may suggest some serious long-term consequences of the Covid pandemic.

Global Youth Fitness – a Few Comments

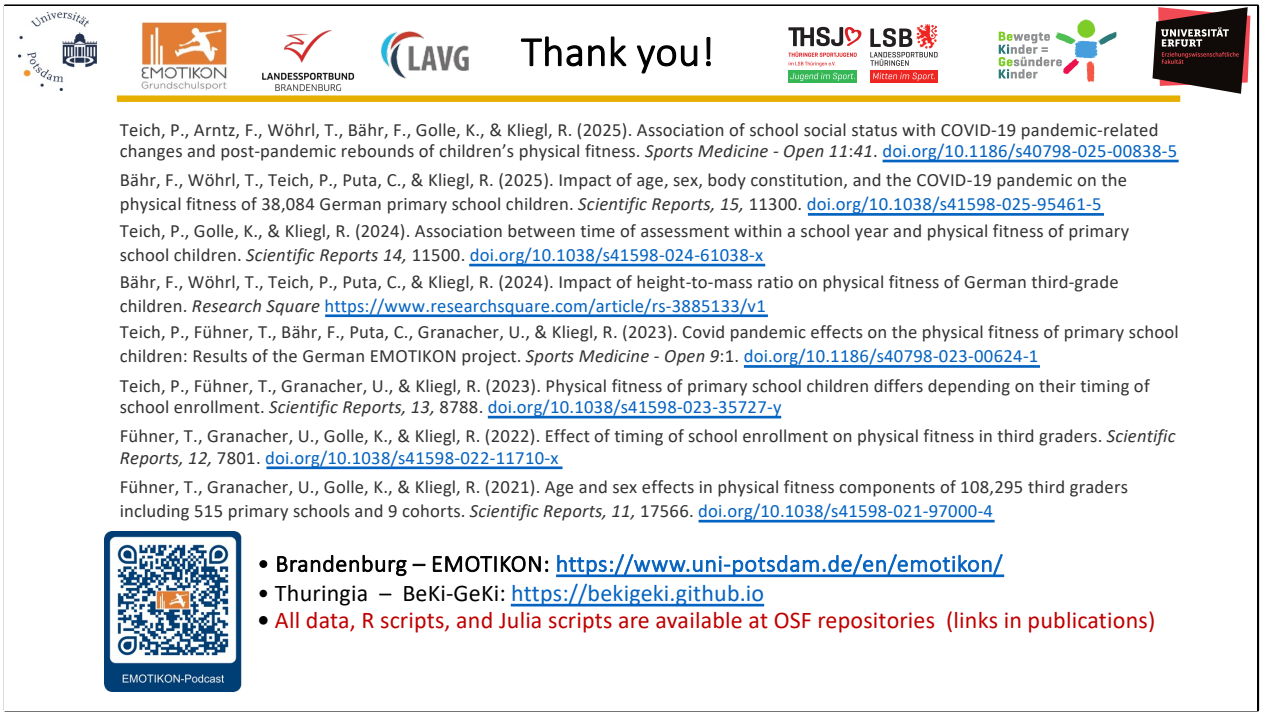
- Our data and scripts are available in Open Science Foundation (OSF) repositories – basis for cooperation?
- Standing long jump – provides link to **YFIT battery**;
  - Mapping of 6-min (et al.) to shuttle run?
  - What tasks relate to hand grip?
  - Metric of shuttle run? Pace or speed?
- **BMI** or **HMR**? Box-Cox analysis shows normal distribution for height and 1/mass => "light"-ness

  Linear model: height + light + height x light ⇔ height + light + height-to-mass ratio (i.e., HMR or HLP);

  -- so far with no evidence of loss of information;

  Bähr et al. (2024): https://www.researchsquare.com/article/rs-3885133/v1

13. How could our projects relate to this consortium? Here are a few thoughts on this.
First, all our data and analyses scripts are available in repos of the Open Science Foundation; cooperation is welcome.
Second, fortunately, with the standing long jump we also have a YFIT task in the test. This might afford a mapping of the 6-minute run to the shuttle run.
Third, the YFIT battery includes BMI. The BMI comes from obesity research. In the context of physical fitness, we prefer to use the height-to-mass ratio. This leads to a simple additive model with two main effects and an interaction. We have seen no loss of information doing this.



14. Visit us on our website! We are doing our best to keep these projects alive and hope that the partners will all stay involved and new ones will join us. Thank you very much!