Supplementary Online Material

Is grip strength linked to body composition and cardiovascular risk markers in primary schoolchildren? Cross-sectional data from three African countries

Per request of one external reviewer, we have controlled our analyses for some further covariates: physical activity, cardiorespiratory fitness (VO_2max), household dietary diversity, and socioeconomic status. In the following sections, we provide a short description of these measures. Afterwards, we provide the results of the regression analyses and ANCOVAs, in which these factors are considered as additional covariates.

Moderate-to-vigorous physical activity

We used light triaxial accelerometers (ActiGraph® wGT3X-BT; Pensacola, United States of America) objectively assess children's physical activity during one regular school week. These monitors proved to be a reliable measure to assess PA levels in prior research.[1] The children wore the accelerometer on 7 consecutive days around the hip, except for activities in water. A sampling rate of 30 Hz was chosen. We then analysed the raw files with the ActiLife software (ActiGraph® version 6.13.2). Days on which children wore the monitor for at least 8 hours were considered valid.[2] Non-wear time was estimated with default settings of the Troiano et al. algorithm.[3] We included only children with valid data on $\geq$4 weekdays and $\geq$1 weekend day.[4] The applied intensity cut-points were specifically defined for children to calculate an overall index for moderate-to-vigorous physical activity.[5]

Cardiorespiratory fitness

We applied the 20m shuttle run test to assess cardiorespiratory fitness (CRF).[6] The test started with a pace of 8.5 km/h. Following sound signals, the speed was then steadily increased by 0.5 km/h. The test was finished when children could no longer follow the speed of the sound signal twice in a row. VO_2max was then predicted based on the total number of fully completed 20m laps, following the equation by Leger et al.[6] Evidence of the reliability and validity of the 20m shuttle run to assess CRF among children has been reported previously.[7]

Dietary diversity

In order to collect information about dietary diversity, we asked parents to complete a food frequency questionnaire (FFQ) to collect information on the consumption of various food items by the children within the past 24 hours. The FFQ was modified according to main local food item consumption additionally to the recommended food items of the Food and Agriculture Organization of the United Nations (FAO).[8, 9] Food items represented the following food groups: (1) cereals (e.g., maize, rice), (2) white roots and tubers (e.g., potatoes), (3) vitamin A rich vegetables (e.g., carrot, pumpkin), (4) green, leafy vegetables (e.g., spinach, sweet potato, leaves), (5) vegetables (e.g., tomato, pepper), (6) vitamin A rich fruits (e.g., mango, peach), (7) fruits (e.g., wild fruits, melon), (8) organ meat (e.g., liver, kidney), (9) flesh meat (e.g., beef, pork), (10) eggs, (11) fish (e.g., dried fish, tuna); (12) legumes, nuts and their products (e.g., beans, peas), (13) milk, milk products (e,g., cheese, cow milk) (14) oil (e.g., oil, butter); (15) sweets (e.g., honey, chocolate); (16) sweet beverages (e.g., sweetened juice drinks, sweetened soda). In the present analyses, we used to the woman dietary diversity score (WDDS) as a measure of dietary diversity. The WDDS reflects the individual probability of nutritional qualitative food sources in the diet. The WDDS score (0-9) included the following aggregated food groups (with 0 reflecting no consumption of any food group and 9 reflecting consumption of all food groups with at least one food item per group): (1) starchy samples (cereals and white roots and tubers), (2) vitamin A rich fruits and vegetables, (3) dark green leafy vegetables, (4) other fruits and vegetables, (5) organ meat, (6) meat and fish, (7) eggs, (8) legumes (legumes, nuts and their products), (9) milk (milk and milk products).[10, 11]

Family socioeconomic status

We assessed family socioeconomic with a questionnaire administered to the caregivers, including nine items which served as proxy variables (e.g., living standards, housing characteristics, water and sanitation condition, possession of durable assets). Each of the 9 items was a dichotomized variable with 0 = not present and 1 = present. An SES score of 9 indicates a high SES. The items were summed up and averaged to build an overall SES score ranging 0-9. In case of one missing item, a family's mean SES score was entered into the dataset. Similar items for SES calculation were previously tested.[12]

Table S1. Association between weight-adjusted HGS, body composition and cardiometabolic risk markers, separately for each study site

	Côte d'Ivoire (*n*=126)[a]			South Africa (*n*=626)[a]			Tanzania (*n*=494)[a]		
	Model 3: Controlled for sex, height, moderate-to-vigorous physical activity, accelerometer wear-time, cardiorespiratory fitness, dietary diversity, and socioeconomic status								
	B (SE)	*95% CI*	*p*	*B*	*95% CI*	*p*	*B*	*95% CI*	*p*
Body composition									
Body fat	**-12.53 (2.43)**	**-17.33 to -7.72**	**<0.001**	**-5.60 (0.95)**	**-7.46 to -3.74**	**<0.001**	**-5.68 (1.54)**	**-8.71 to -2.66**	**<0.001**
Muscle mass	**11.85 (2.33)**	**7.24 to 16.46**	**<0.001**	**5.28 (0.89)**	**3.53 to 7.03**	**<0.001**	**5.28 (1.44)**	**2.44 to 8.12**	**<0.001**
Fat free mass	**12.55 (2.44)**	**7.73 to 17.36**	**<0.001**	**5.62 (0.95)**	**3.75 to 7.49**	**<0.001**	**5.63 (1.54)**	**2.61 to 8.66**	**<0.001**
Cardiovascular risk markers									
Systolic blood pressure	-3.45 (9.24)	-21.71 to 14.80	0.709	-0.10 (2.53)	-5.06 to 4.87	0.970	**14.58 (6.61)**	**1.58 to 27.58**	**0.028**
Diastolic blood pressure	2.52 (8.67)	-14.61 to 19.65	0.771	0.51 (2.09)	-3.60 to 4.61	0.809	2.34 (3.81)	-5.12 to 9.86	0.535
Total cholesterol	1.17 (0.61)	-0.03 to 2.38	0.057	0.20 (0.15)	-0.10 to 0.50	0.193	0.13 (0.32)	-0.49 to 0.75	0.677
HDL cholesterol	0.39 (0.29)	-0.18 to 0.96	0.178	-0.01 (0.08)	-0.17 to 0.14	0.888	0.25 (0.15)	-0.06 to 0.55	0.113
LDL cholesterol	1.02 (0.54)	-0.05 to 2.09	0.063	0.22 (0.13)	-0.03 to 0.47	0.087	-0.42 (0.25)	-0.91 to 0.08	0.100
Triglycerides	-0.52 (0.34)	-1.19 to 0.14	0.123	-0.01 (0.05)	-0.12 to 0.09	0.814	0.11 (0.12)	-0.13 to 0.35	0.371
Glycated hemoglobin (HbA1c)	-0.15 (0.37)	-0.88 to 0.58	0.679	0.08 (0.07)	-0.06 to 0.21	0.258	0.06 (0.13)	-0.20 to 0.31	0.676

Notes. [a]Lower sample sizes compared to results reported in the main manuscript are due to further missing data in additionally considered covariates (physical activity, cardiorespiratory fitness, dietary diversity, and socioeconomic status). Significant results are marked in bold font.

Table 2. Differences between HGS quartiles in body composition and cardiometabolic risk markers, separately for each study site

	Côte d'Ivoire (*n*=126)[f]									
	Quartile 1 (*n*=45)		Quartile 2 (*n*=42)		Quartile 3 (*n*=40)		Quartile 4 (*n*=35)		ANCOVA	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	η^2
BF	**21.26^{abc}**	**3.05**	**19.81^{ade}**	**3.09**	**18.86^{bd}**	**2.49**	**17.65^{ce}**	**3.12**	**8.51*** **	**0.145**
MM	**74.35^{abc}**	**2.77**	**75.82^{ade}**	**2.90**	**76.53^{bd}**	**2.24**	**77.66^{ce}**	**2.93**	**8.36*** **	**0.142**
FFM	**78.74^{abc}**	**3.04**	**80.19^{ade}**	**3.07**	**81.11^{bd}**	**2.47**	**82.39^{ce}**	**3.09**	**8.80*** **	**0.149**
SBP	99.09	10.01	101.77	9.62	100.50	8.55	99.62	9.53	0.29	0.006
DBP	67.19	9.32	67.84	9.94	67.22	8.86	67.47	8.11	0.17	0.003
TC	3.67	0.75	3.63	0.59	3.65	0.71	3.71	0.66	0.33	0.006
HDL-C	1.07	0.32	1.12	0.38	1.18	0.38	1.16	0.32	0.62	0.012
LDL-C	2.06	0.67	2.00	0.46	1.97	0.57	2.07	0.56	0.67	0.010
TRIG	1.18	0.34	1.14	0.28	1.09	0.34	1.07	0.34	0.40	0.019
HbA1c	5.02	0.36	5.07	0.41	4.98	0.39	0.94	0.41	0.60	0.012
	South Africa (*n*=626)[f]									
	Quartile 1 (*n*=139)		Quartile 2 (*n*=158)		Quartile 3 (*n*=167)		Quartile 4 (*n*=162)		ANCOVA	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	η^2
BF	**24.58^{ab}**	**5.03**	**23.01^{cd}**	**4.59**	**21.33^{ace}**	**3.34**	**19.99^{bde}**	**2.99**	**20.99*** **	**0.093**
MM	**71.21^{ab}**	**4.63**	**72.68^{cd}**	**4.24**	**74.28^{ace}**	**3.09**	**75.48^{bde}**	**2.76**	**21.20*** **	**0.094**
FFM	**75.42^{ab}**	**5.04**	**76.99^{cd}**	**4.59**	**78.69^{ace}**	**3.35**	**80.01^{bde}**	**3.00**	**21.03*** **	**0.093**
SBP	100.11	12.08	11.85	10.47	102.11	11.07	102.15	10.70	0.18	0.001
DBP	62.75	8.33	63.59	8.85	63.11	8.38	63.20	8.75	0.32	0.002
TC	3.62	0.64	3.55	0.61	3.62	0.52	3.69	0.62	1.66	0.008
HDL-C	1.24	0.29	1.21	0.28	1.24	0.31	1.26	0.32	1.68	0.008
LDL-C	2.04	0.53	2.00	0.50	2.06	0.48	2.10	0.52	0.57	0.003
TRIG	0.76	0.24	0.74	0.22	0.70	0.19	0.74	0.22	2.29	0.011
HbA1c	5.38	0.25	5.43	0.26	5.44	0.24	5.43	0.25	0.48	0.002
	Tanzania (*n*=494)[f]									
	Quartile 1 (*n*=132)		Quartile 2 (*n*=122)		Quartile 3 (*n*=122)		Quartile 4 (*n*=118)		ANCOVA	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	η^2
BF	**21.91^{ab}**	**4.16**	**21.01^{cd}**	**3.57**	**19.69^{ace}**	**3.57**	**18.29^{bde}**	**3.55**	**9.49*** **	**0.040**
MM	**73.78^{ab}**	**3.86**	**74.67^{cd}**	**3.32**	**75.91^{ace}**	**4.28**	**77.16^{bde}**	**3.32**	**9.30*** **	**0.039**
FFM	**78.09^{ab}**	**4.16**	**79.01^{cd}**	**3.56**	**80.30^{ace}**	**3.57**	**81.71^{bde}**	**3.57**	**9.34*** **	**0.039**
SBP	103.36	10.38	104.28	10.38	104.85	11.75	107.51	17.78	1.33	0.006
DBP	67.20	8.05	67.07	8.49	67.61	8.91	67.47	7.84	0.09	0.000
TC	3.75	0.65	3.86	0.64	3.81	0.79	3.72	0.56	1.35	0.006
HDL-C	1.24	0.32	1.33	0.56	1.28	0.34	1.30	0.35	1.19	0.005
LDL-C	2.17	0.55	2.22	0.50	2.14	0.57	2.07	0.49	1.22	0.005
TRIG	0.72	0.23	0.79	0.31	0.81	0.43	0.76	0.31	1.55	0.007
HbA1c	5.43	3.40	5.15	0.32	5.14	0.32	5.16	0.33	1.03	0.004

Notes. BF = Body fat (in %). MM = Muscle mass (in %). FFM = Fat-free mass (in %). SBP = Systolic blood pressure (in mm Hg). DBP = Diastolic blood pressure (in mm Hg). TC = Total cholesterol (in mmol/L). HDL-C = HDL cholesterol (in mmol/L). LDL-C (in mmol/L). TRIG = Triglycerides (in mmol/L). HbA1c = Glycated hemoglobin (in %). ANCOVAs controlled for sex and height. Mean scores with the same superscript letters$^{(a\text{-}e)}$ are significantly different (p<0.05), based on Bonferroni post-hoc tests. [f]Lower sample sizes compared to results reported in the main manuscript are due to further missing data in additionally considered covariates (physical activity, cardiorespiratory fitness, dietary diversity, and socioeconomic status). Significant results are marked in bold font.

*p<0.05. **p<0.01. ***p<0.001.

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