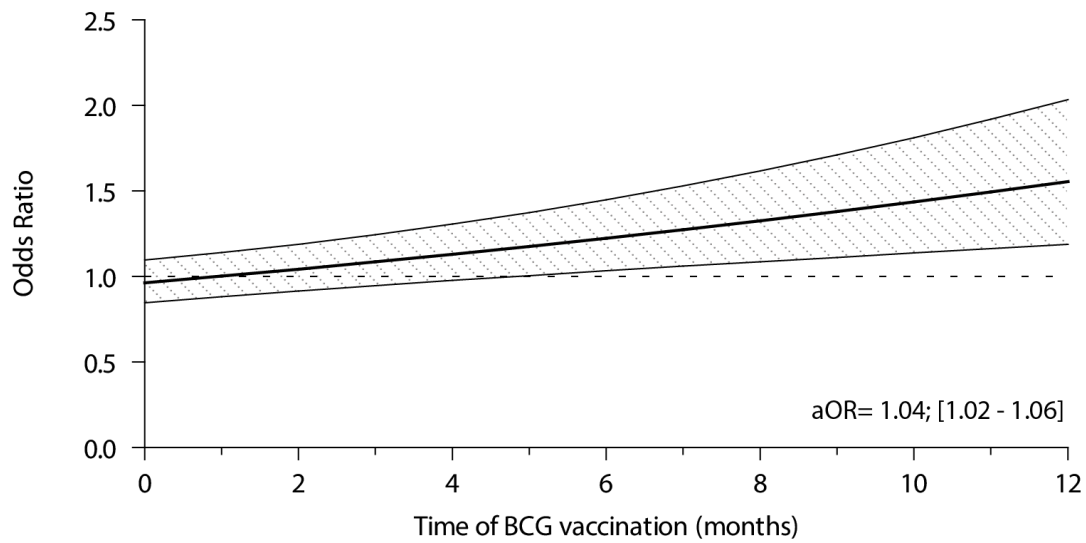


1

2 **Supplementary Figure 1. Sensitivity analyses for BCG vaccination according to mothers' recall.** Thick-smear  
3 microscopy as diagnostic, removal of children protected by maternal antibodies (age  $\leq$  6months), removal of  
4 areas with a BCG coverage  $\geq$ 90% and a combination of the latter two were used as sensitivity analyses of the  
5 association between BCG vaccination and malaria prevalence. All results are depicted as adjusted odds ratios  
6  $\pm$ 95% CI retrieved from multilevel logistic regression analyses with 4 levels (child, cluster, region and country)  
7 with correction for age, birth order, sex, twin, place of delivery, size at birth, preceding birth interval, weight-for-  
8 age z-score, breastfeeding, other vaccinations, vitamin A supplementation, use of bed nets, maternal age, maternal  
9 BMI, number of births by mother in last 5 years, maternal level of education, maternal partner, household size,  
10 quality of drinking water, quality of toilet facility, international wealth index and urbanization level. BCG: Bacillus  
11 Calmette-Guérin. \*\*P-value  $<$ 0.01, \*\*\*P-value  $<$ 0.001.



12

13 **Supplementary Figure 2. Time-dependency of the association between BCG vaccination and stunting.**

14 Results are depicted as adjusted odds ratios  $\pm$ 95% CI retrieved from multilevel logistic regression analyses with  
15 4 levels (child, cluster, region and country) with correction for age, birth order, sex, twin, place of delivery, size  
16 at birth, preceding birth interval, weight-for-age z-score, breastfeeding, other vaccinations, vitamin A  
17 supplementation, use of bed nets, maternal age, maternal BMI, number of births by mother in last 5 years,  
18 maternal level of education, maternal partner, household size, quality of drinking water, quality of toilet facility,  
19 international wealth index and urbanization level. BCG: Bacillus Calmette-Guérin.

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21

22 **Supplementary table 1. Rapid Diagnostic Tests (RDTs) used in the included countries.**

Country (ISO code)	Brand and type of RDT	Malaria species detectable
<b>West-Africa</b>		
Benin (BEN)	Paracheck Pf	<i>P. falciparum</i>
Burkina Faso (BFA)	Paracheck Pf	<i>P. falciparum</i>
Ivory Coast (CIV)	SD Bioline Malaria Ag P.f	<i>P. falciparum</i>
Ghana (GHA)	SD Bioline Malaria Ag P.f/Pan	All <i>P. species</i>
Guinea (GIN)	First Response Malaria pLDH/HRP2 combo	All <i>P. species</i>
Mali (MLI)	SD Bioline Malaria Ag P.f	<i>P. falciparum</i>
Togo (TGO)	First Response Malaria pLDH/HRP2 combo	All <i>P. species</i>
<b>Central-Africa</b>		
Angola (AGO)	SD Bioline Malaria Ag P.f/P.v	<i>P. falciparum</i> , <i>P. vivax</i>
Cameroon (CMR)	SD Bioline Malaria Ag P.f/Pan	All <i>P. species</i>
Democratic Republic of Congo (COD)	SD Bioline Malaria Ag P.f	<i>P. falciparum</i>
<b>East-Africa</b>		
Mozambique (MOZ)	SD Bioline Malaria Ag P.f/P.v	<i>P. falciparum</i> , <i>P. vivax</i>
Rwanda (RWA)	First Response Malaria pLDH/HRP2 combo	All <i>P. species</i>
United Republic of Tanzania (TZA)	SD Bioline Malaria Ag P.f/Pan	All <i>P. species</i>

23

24 **Supplementary table 2. Distribution of malaria prevalence and BCG coverage in the included countries**

Country (ISO code)	Children included N (%)	Malaria cases N (%)	Received BCG N (%)
<b>West-Africa</b>			
Benin (BEN)	588 (1.7)	170 (28.9)	491 (83.5)
Burkina Faso (BFA)	2,254 (6.6)	1,699 (75.4)	2,139 (94.9)
Ivory Coast (CIV)	2,472 (7.2)	976 (39.5)	2,058 (83.2)
Ghana (GHA)	2,617 (7.7)	1,030 (39.4)	2,515 (96.1)
Guinea (GIN)	1,276 (3.7)	659 (51.6)	1,031 (80.8)
Mali (MLI)	2,255 (6.6)	1,114 (49.4)	1,749 (77.6)
Togo (TGO)	812 (2.4)	329 (40.5)	769 (94.7)
<b>Central-Africa</b>			
Angola (AGO)	1,051 (3.1)	266 (25.3)	638 (60.7)
Cameroon (CMR)	2,439 (7.1)	678 (27.8)	2,158 (88.5)
Democratic Republic of Congo (COD)	8,954 (26.2)	2,891 (32.3)	7,413 (82.8)
<b>East-Africa</b>			
Mozambique (MOZ)	3,077 (9.0)	1,261 (41.0)	2,708 (88.0)
Rwanda (RWA)	675 (2.0)	89 (13.2)	670 (99.3)
United Republic of Tanzania (TZA)	5,736 (16.8)	1,163 (20.3)	5,427 (94.6)
<b>Total</b>	<b>34,206 (100.0)<sup>a</sup></b>	<b>12,325 (36.0)</b>	<b>29,766 (87.0)</b>

<sup>a</sup>Percentages of the separate countries do not add up to 100 due to rounding of the individual numbers.

25

26

27 **Supplementary table 3. Concordance of malaria diagnosis by rapid diagnostic test and thick-smear**  
 28 **microscopy in all children with information of both diagnostics.**

		Malaria RDT		
		Positive	Negative	Total
Malaria thick-smear microscopy	Positive	5,833	1,373	7,206
	Negative	3,674	15,251	18,925
	<b>Total</b>	<b>9,507</b>	<b>16,624</b>	<b>26,131<sup>a</sup></b>

<sup>a</sup>Number is based on all children that have values for malaria RDT and malaria thick-smear microscopy.

29

30 **Supplementary table 4. Number of children with available data for variables with missings.**

Item	All children N=34,206	Not BCG vaccinated N=4,441	BCG vaccinated N=29,765
Malaria blood slide	26,132 (76.4)	3,351 (75.5)	22,781 (76.5)
Place of delivery	34,088 (99.7)	4,388 (98.8)	29,700 (99.8)
Size at birth	33,498 (97.9)	4,183 (94.2)	29,316 (98.5)
Preceding birth interval	26,256 (76.8) <sup>a</sup>	3,559 (80.1)	22,698 (76.3)
Weight Z-score	34,081 (99.6)	4,420 (99.5)	29,661 (99.7)
Breastfeeding	34,037 (99.5)	4,372 (98.4)	29,665 (99.7)
Received all other vaccines according to national schedule	33,834 (98.9)	4,441 (100.0)	29,393 (98.8)
Received Vitamin A	33,954 (99.3)	4,320 (97.3)	29,634 (99.6)
Slept under bed net last night	32,930 (96.3)	4,196 (94.5)	28,734 (96.5)
BMI of mother	28,514 (83.4) <sup>b</sup>	3,395 (76.4)	25,119 (84.4)
Level of education	34,181 (99.9)	4,437 (99.9)	29,745 (99.9)
Mother has partner	34,154 (99.8)	4,433 (99.8)	29,721 (99.9)
Drinking water quality	34,200 (100.0)	4,440 (100.0)	29,760 (100.0)
Toilet facility quality	34,197 (100.0)	4,436 (99.9)	29,761 (100.0)
<b>Combined</b>	<b>20,077 (58.7)</b>	<b>2,304 (51.9)</b>	<b>17,772 (59.7)</b>

Data are displayed as N (%) of children with available data. <sup>a</sup>All missings were because the child was the mothers first child. <sup>b</sup>4,550 missing because mother was currently pregnant.

31

32 **Supplementary table 5. Full model of the association between BCG and malaria, excluding all children**  
 33 **with missing values on any of the covariates.**

Item	Coefficient	Standard Error	T-value	Adjusted odds ratio	P-value
<b>Child level</b>					
BCG vaccination					
No	ref				
BCG based on recall	-0.045	0.043	-1.047	0.96 (0.88-1.04)	0.30
BCG based on card	-0.145	0.052	-2.788	<b>0.87 (0.78-0.96)</b>	<b>0.0053</b>
Age in months	0.06	0.004	15.000	<b>1.06 (1.05-1.07)</b>	<b>&lt;0.0001</b>
Age in months (squared)	-0.001	0.000	-9.429	<b>1.00 (1.00-1.00)</b>	<b>&lt;0.0001</b>
Birth order number	0.035	0.017	2.059	<b>1.04 (1.00-1.07)</b>	<b>0.040</b>
Sex					
Male	ref				
Female	-0.013	0.024	-0.542	0.99 (0.94-1.03)	0.59
Twin	0.011	0.095	0.116	1.01 (0.84-1.22)	0.91
Place of delivery					
Not at hospital	ref				
Public hospital	-0.188	0.048	-3.917	<b>0.83 (0.75-0.91)</b>	<b>&lt;0.0001</b>
Private hospital	-0.289	0.081	-3.568	<b>0.75 (0.64-0.88)</b>	<b>0.00036</b>
Size at birth					
Small	ref				
Average	0.041	0.045	0.911	1.04 (0.95-1.14)	0.36
Large	0.031	0.038	0.816	1.03 (0.96-1.11)	0.42
Preceding birth interval	-0.002	0.001	-2.000	<b>1.00 (1.00-1.00)</b>	<b>0.046</b>

Weight Z-score	0.002	0.018	0.111	1.00 (0.97-1.04)	0.91
Breastfeeding					
Never	ref				
Ever, not currently	-0.137	0.107	-1.280	0.87 (0.71-1.08)	0.20
Currently	-0.115	0.11	-1.045	0.89 (0.72-1.11)	0.30
Received all other vaccines for child's age according to national schedule	-0.063	0.064	-0.984	0.94 (0.83-1.06)	0.33
Received Vitamin A	-0.073	0.056	-1.304	0.93 (0.83-1.04)	0.19
Slept under bednet last night					
No	ref				
Untreated net	-0.213	0.135	-1.578	0.81 (0.62-1.05)	0.12
Treated net	-0.004	0.044	-0.091	1.00 (0.91-1.09)	0.93
<b>Maternal level</b>					
Age of mother in years	-0.013	0.005	-2.600	<b>0.99 (0.98-1.00)</b>	<b>0.0093</b>
BMI of mother	-0.031	0.006	-5.167	<b>0.97 (0.96-0.98)</b>	<b>&lt;0.0001</b>
Number of births in the last 5 years	0.09	0.026	3.462	<b>1.09 (1.04-1.15)</b>	<b>0.00054</b>
Level of education					
No	ref				
Primary	-0.049	0.049	-1.000	0.95 (0.86-1.05)	0.32
Secondary	-0.318	0.058	-5.483	<b>0.73 (0.65-0.82)</b>	<b>&lt;0.0001</b>
Higher	-0.136	0.15	-0.907	0.87 (0.65-1.17)	0.37
Mother has partner	-0.072	0.066	-1.091	0.93 (0.82-1.06)	0.28
<b>Household level</b>					
Household size	0.023	0.01	2.300	<b>1.02 (1.00-1.04)</b>	<b>0.021</b>
Quality drinking water					
Low	ref				
Medium	-0.041	0.062	-0.661	0.96 (0.85-1.08)	0.51
High	0.013	0.063	0.206	1.01 (0.90-1.15)	0.84
Quality toilet facility					
Low	ref				
Medium	-0.226	0.056	-4.036	<b>0.80 (0.71-0.89)</b>	<b>&lt;0.0001</b>
High	-0.253	0.123	-2.057	<b>0.78 (0.61-0.99)</b>	<b>0.040</b>
International Wealth Index	-0.001	0.004	-0.250	1.00 (0.99-1.01)	0.80
International Wealth Index squared	-0.000 <sup>a</sup>	0.000	-3.167	<b>1.00 (1.00-1.00)</b>	<b>0.0015</b>
Urbanization level					
Urban	ref				
Rural	0.547	0.095	5.758	<b>1.73 (1.43-2.08)</b>	<b>&lt;0.0001</b>

<sup>a</sup>Negative sign indicates a significant negative coefficient. Model is a multilevel model including 4 levels (child, cluster, region and country). BCG: Bacillus Calmette-Guérin.

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42 **Supplementary table 6. Percentage of reduction in malaria prevalence possible if the association between**  
 43 **BCG and malaria would be attributable to the non-specific effects of BCG.**

	OR	Fraction not BCG vaccinated	Fraction malaria positive		RR	Absolute risk reduction		Percentage reduction possible
			Non-vaccinated group (P0)	Total Population		Non- vaccinated group	Total Population	
<b>Overall</b>	0.87	0.13	0.46	0.36	0.93	0.034	0.0045	<b>1.24</b>
<b>Regions with &lt;90% BCG coverage</b>	0.81	0.22	0.47	0.39	0.89	0.052	0.011	<b>2.93</b>
<b>Angola regions</b>								
Zaire	0.81 <sup>a</sup>	0.12	0.14	0.15	0.83	0.024	0.0031	2.04
Uige	0.81 <sup>a</sup>	0.38	0.46	0.32	0.89	0.052	0.020	6.14
Cuanza Norte	0.81 <sup>a</sup>	0.33	0.36	0.33	0.87	0.047	0.016	4.70
Cuanza Sul	0.81 <sup>a</sup>	0.57	0.23	0.21	0.85	0.035	0.020	9.55
Malanje	0.81 <sup>a</sup>	0.24	0.26	0.22	0.85	0.038	0.0092	4.20
Lunda Norte	0.81 <sup>a</sup>	0.43	0.23	0.17	0.85	0.035	0.015	8.90
Bie	0.81 <sup>a</sup>	0.35	0.36	0.31	0.87	0.047	0.017	5.46
Moxico	0.81 <sup>a</sup>	0.61	0.41	0.32	0.88	0.050	0.030	9.50
Cuando Cubango	0.81 <sup>a</sup>	0.59	0.57	0.38	0.91	0.052	0.031	8.11

44 <sup>a</sup>Overall OR for regions with <90% BCG coverage was used. OR: Odds ratio, RR: Relative risk

#### 45 **Calculation of reduction in malaria prevalence**

46 To provide a sense of the effects that can be expected from BCG vaccination, we calculated the expected  
 47 reduction in malaria prevalence when all children would have received vaccination with BCG using the formula  
 48 described by Zhang and Yu for transformation of the odds ratios to relative risks.<sup>1</sup>

49

$$50 \quad RR = \frac{OR}{((1 - P0) + (P0 * OR))}$$

51

52 The resulting relative risks are only an approximation of the true relative risks. Based on these risks the absolute  
 53 reduction in malaria prevalence was calculated for the non-vaccinated group and the total population. The latter  
 54 was converted to the percentage of reduction in malaria prevalence possible if the association between BCG and  
 55 malaria would be attributable to the non-specific effects of BCG. This resulted in possible reductions of 1-3% for  
 56 the overall population, but up to 10% for individual regions with low BCG coverage.

57

#### 58 **References for supplementary material**

59 1. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of  
 60 common outcomes. *JAMA*. 1998; 280(19): 1690–1.